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NEW JERSEY APPROACH TO THE GEORGE WASHINGTON BRIDGE, HUDSON RIVER

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MARCH 1932

MacARTHUR finishes another tough job ahead of schedule . . . PILES for New York City's West Side Elevated Highway

Poirier and MacLane, New York, *General Contractors*
C. M. Pinckney, *Chief Engineer*, Bureau of Highways, City of New York

The west shore of Manhattan Island is recognized as one of the most difficult areas in New York in which to drive piles because of sub-surface obstructions in the "made land" which have to be penetrated.

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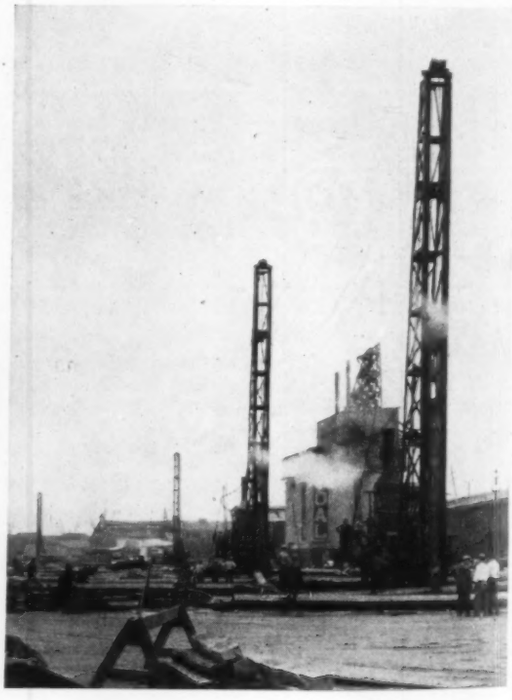

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Among Our Writers

CARLTON S. PROCTOR's firm has specialized in foundation work not only for buildings but also for bridges and other heavy structures. The development of open-pit methods for New York conditions is one of the firm's recent accomplishments.

LAZARUS WHITE was an engineer on the construction of the original subway in New York from 1900 to 1906, and has been closely connected with subway work since. The engineering and contracting firm of which he is a member specializes in foundations.

JOSEPH J. YATES has been Bridge Engineer of the Central Railroad Company of New Jersey since 1907 and has acted as consulting engineer on foundations for many large bridges near New York and elsewhere.

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WALTER H. WHEELER designed the notable concrete arch bridge at Minneapolis between Fort Snelling and Mendota, known as the Mendota Bridge.

GEORGE OTIS SMITH, Director of the U.S. Geological Survey from 1907 to 1931, early contended for the development of water power under public regulation. Fact-finding in the public interest has been the dominant purpose of his 36 years of Government service.

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J. L. BAUER, before he became State Highway Engineer of New Jersey, was engaged in the design and construction of roads and bridges for Union County, N.J., and numerous included boroughs and townships. He has acted as consulting engineer on several large housing projects.

LANGDON PEARSE, an expert on water supply and sewage works, has appeared as a witness in various U.S. Supreme Court cases concerning water diversions in Chicago. His connection with the Sanitary District of Chicago dates back to 1909.

WELLINGTON DONALDSON has devoted 25 years of study to the technical supervision of water purification and sewage treatment plants and to the design of such plants from the standpoint of the plant operator.

SAMUEL A. GREELEY had the privilege of an early association with the late Rudolph Hering in sanitary engineering practice. Mr. Greeley is an acknowledged expert on water supply and sewage treatment.

E. B. BLACK's firm has a nation-wide practice handling water supply and sewerage projects, and appraisals for rate cases. Mr. Black personally directed the construction of Camp Pike during the War.

ARTHUR W. CONSOER served on the water supply staff of the A.E.F. as Captain of Engineers. Since 1919 he has specialized in municipal improvements. In 1924 he became a member of the Chicago firm of Consoer, Older, and Quinlan.

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J. K. FINCH had several years of practical experience before he became connected with the civil engineering department of Columbia University in 1910. Since 1920 he has been Director of the University's Summer School of Surveying.

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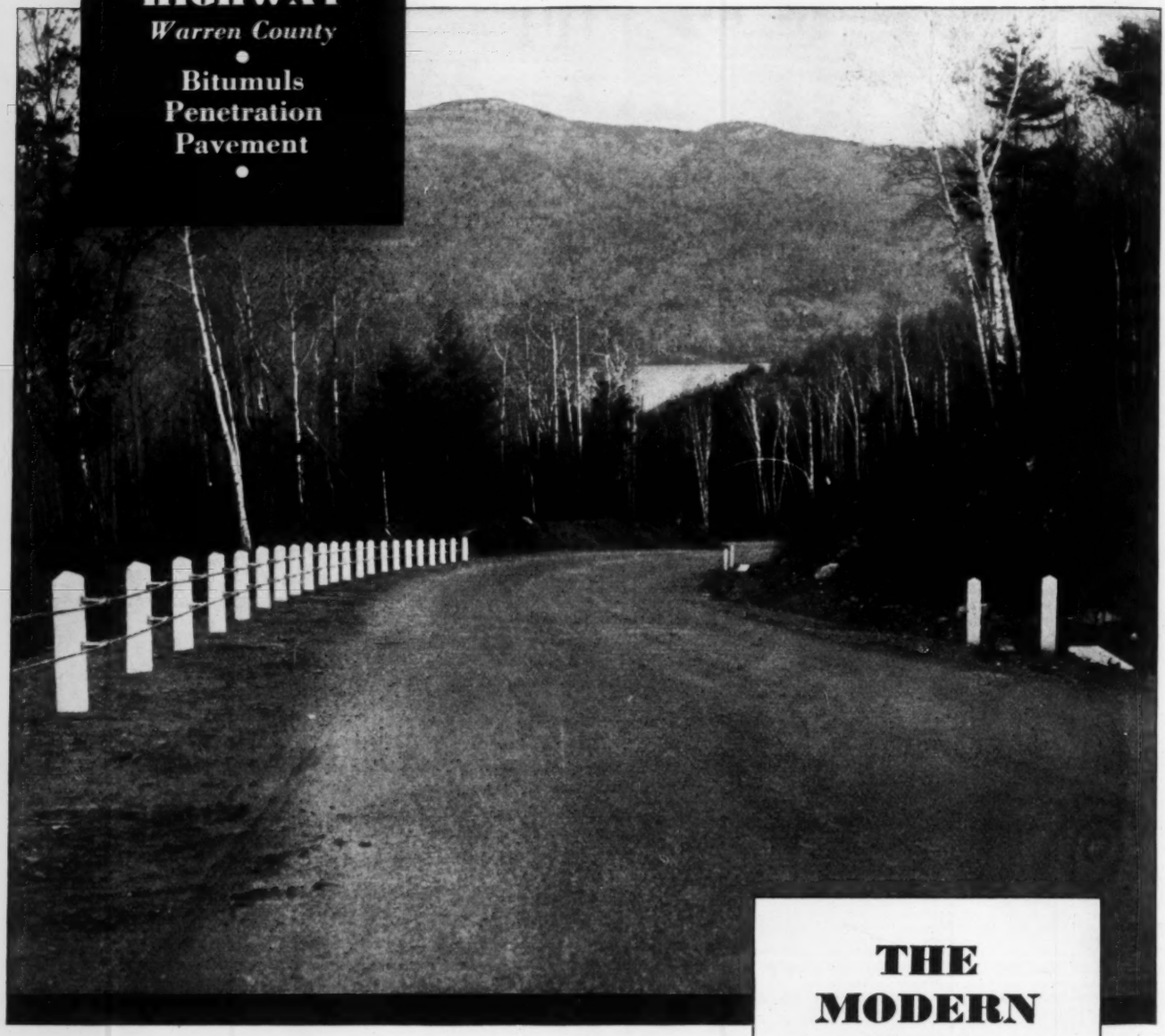

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Modern Foundation Practice

For Buildings, Subways, and Bridges

SAFE and economic foundations probably call for more individual study and judgment in their design and construction than does any other type of structure. Soil conditions are never exactly the same at any two sites, and the use of conventional designs without regard to soil variations and economic methods of construction may result in serious financial loss or failure of the structure. In the articles which follow, abstracts of papers presented on January 21, 1932, before the joint session of the Construction and Structural Divisions at the Annual Meeting of the Society in New York, each author, an expert in his field, describes the advances that have been made in design and emphasizes the necessity for determining soil characteristics in order that foundations may be safe, yet not over-designed.

Three different aspects of foundation practice are dealt with. In the first article, Mr. Proctor outlines the various types of foundations in use and explains the trend toward open-pit excavation for the supports of tall and heavy buildings. The author of the second paper, Mr. White, is concerned with the accurate determination of the stresses to be withstood by the foundations and floors of subways and their proper design, with special reference to waterproofing and groundwater pressures. In the last article, Mr. Yates outlines the necessary steps in making an investigation for the design of a bridge foundation and shows the importance of taking into consideration, in the design, the construction methods to be followed. He finds that concrete deposited under water, even with careful supervision, too often gives poor results.

Deep Foundations for High Buildings

By CARLTON S. PROCTOR
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ENGINEER, NEW YORK

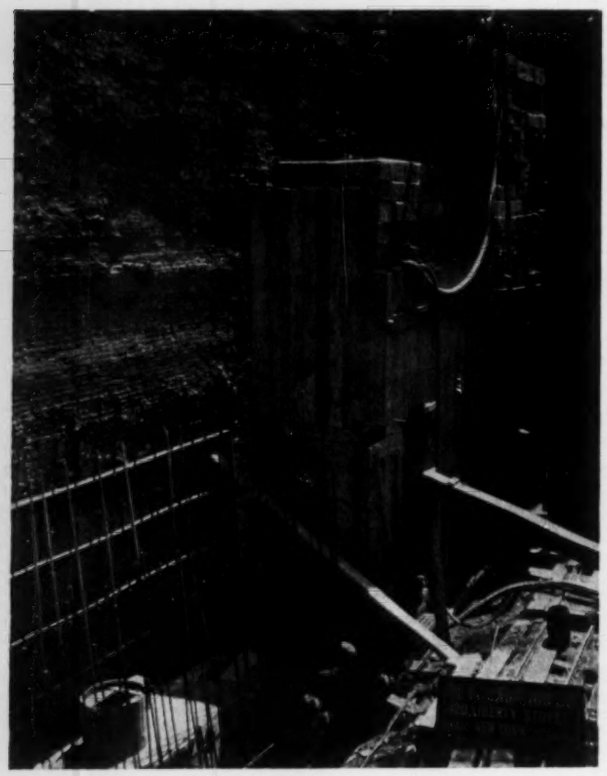
ALTHOUGH, theoretically, engineering problems in connection with foundations involve the same considerations of forces acting on matter as do the problems of structural design, there are several fundamental differences. In the first place, the physical properties of "materials of construction" are well known and standardized, while the beds of natural materials which underlie structures have not yet been adequately studied and classified. Another difference is that, in most modern engineering designs, lateral deformations, if not excessive, may be ignored, whereas the possibility of lateral movement of soils greatly complicates the study of foundation problems, tending to obscure the results of experimental work on all granular and plastic materials. Further, there is the factor of engineering specialization; most engineers are interested primarily in one of the main branches of engineering and only secondarily, and often superficially, in foundation design. Local and individual prejudices as to types of foundation and methods of construction have frequently and absurdly influenced the choice of a design.

Foundation engineering is in my opinion a definite branch of the profession, continually leading to new methods and new solutions, and requiring constant investigation and research. Contrary to the common belief that it is a restricted field, foundation engineering concerns bridges, buildings, dams, power houses, tunnels and many other subsurface structures, and involves questions relative to soil mechanics and the geology of the site, as well as studies concerning the economics of the foundation relative to the project involved. Frequently only experience and safety of construction methods dictate the type of design adopted. In the design of difficult foundations, the engineer cannot safely follow either the standards illustrated in engineering handbooks, standardized designs, or layouts of previous structures, except in a general way. Of the foundation failures with which I am familiar, whether structural or economical, in practically every case the difficulty can be traced to an attempt by the engineer to use a previously successful design, or to follow the advice of a salesman specializing in a particular type of foundation installation.

SOIL CONDITIONS OFTEN DIFFICULT

The most complicated problems in the design and construction of building foundations naturally arise where foundation conditions are the worst. Navigable water has been a controlling factor in the location, growth,

and development of our principal cities, and therefore the heaviest structures must frequently be erected on alluvial deposits, which usually form the banks of rivers and lakes, and the shores at tidewater.



BUILDING PNEUMATIC COFFERDAM WALL AROUND CHASE NATIONAL BANK SITE, NEW YORK, 1927

At Left, Forms and Reinforcing for Caisson Working Chamber. At Right, Weighted Caisson Being Sunk

OPEN TRENCH CONSTRUCTION, LEE-HIGGINSON BUILDING, 1928

Steel Sheet Piling Braced with Timber; New York, 1928

Over Manhattan Island this type of soil deposit is found only within a block or two of the two rivers; elsewhere an excellent bedrock is generally reachable. In many of our larger cities, however, such deposits cover considerable areas and it is frequently impracticable to reach a material capable of supporting such loads as those of New York's highest skyscrapers. Subsoil conditions are not the same in any two localities.

In Philadelphia the terrain overlying bedrock is somewhat similar to that in downtown New York, but the bedrock in New York has been scoured by glacial action so that the disintegrated soft rock has been largely removed, and the remaining rock protected against further disintegration by the post-glacially deposited blanket of hardpan. The glacial movement did not reach as far south as Philadelphia, and in that locality the bedrock is soft and disintegrated to considerable depths.

Because of the absence of glacial scour south of New York, foundation problems of considerable magnitude are encountered in many localities in the South. In some cities, of which Atlanta, Ga., is a notable example, the residue of bedrock disintegration has left a subsoil material far less dependable than ordinary sand deposits. Frequently it is not only valueless as a supporting material, because of its soft slippery consistency, but difficult and expensive to remove because of its considerable depth and water content.

In such cities as Albany and Cleveland, bedrock is generally at such depths below grade as to be unreachable, and the deposits over bedrock in both cases consist primarily of clay. In Albany the clay is so highly saturated that, particularly on Capitol Hill, the addition of any appreciable load on the soil starts a flow of water from the voids in the clay structure, and hence a relatively lightly loaded foundation will usually continue to settle for a considerable period.

The problem in Albany is particularly serious because the expulsion of water from loaded areas creates adjacent supersaturated areas resulting in deep lateral movements in the clay, a condition for which it has been found necessary to devise an entirely new and radical type of foundation. Briefly, this type requires a cellar excavation of sufficient depth to remove from the area a clay load equivalent to the load to be superimposed, the entire substructure being designed as a series of interconnected two-story Vierendeel trusses, or rigid frames, as shown in Fig. 1, to distribute the weight of the building uniformly on the bearing soil.

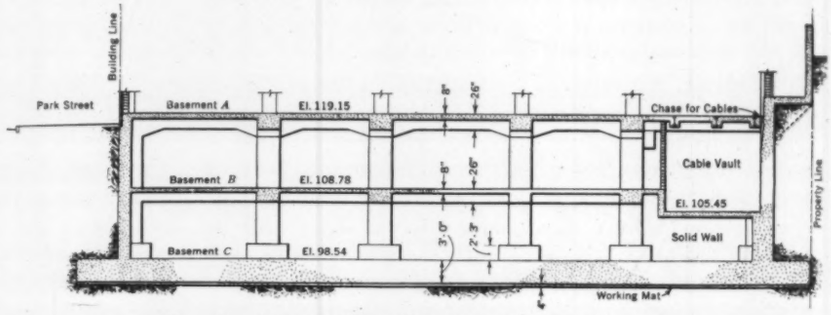


FIG. 1. ALBANY MAIN TELEPHONE BUILDING

Basement Floors, Walls, and Columns Form Vierendeel Trusses

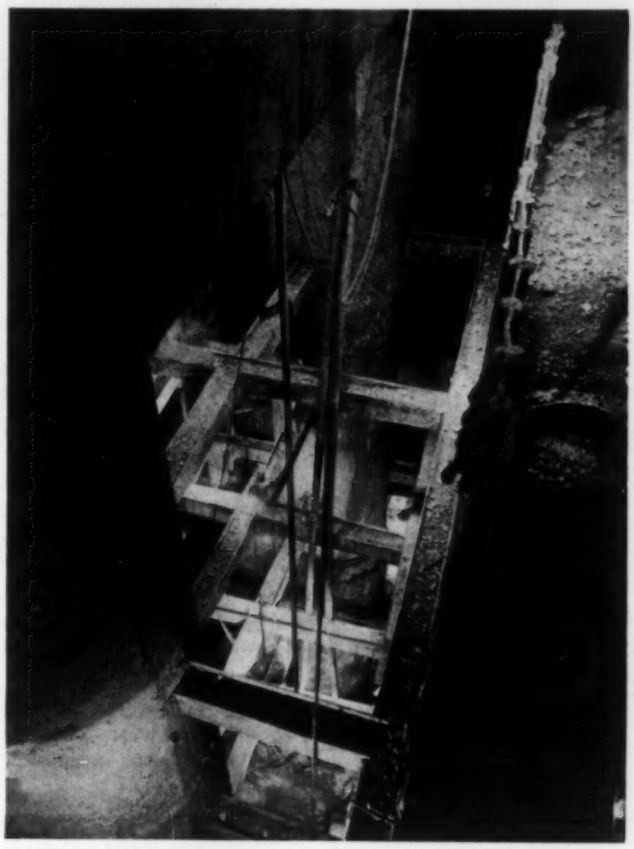
The primary function of a building foundation is to provide adequate support for the structure against downward or lateral movement, and to do this with the maximum economy consistent with safety. In general,

the required vertical support can be obtained by one or more methods of construction, which may be classified roughly as follows:

1. Spread footings, independent or combined; a reinforced concrete mat of heavy continuous construction over the entire area of the site; combinations of individual footings interconnected to form the so-called "waffle mat"; or a cellular type of mat utilizing two or more basement floors, walls, and columns combined as Vierendeel trusses.
2. Pile foundations, using, according to conditions, either timber, concrete, or composite piles, or concrete-filled steel tubes, with load capacity depending either on skin friction or point bearing.
3. Piers to underlying hardpan or rock, installed by various open or pneumatic methods.
4. Cofferdam walls located on the perimeter of the site, providing opportunity for excavation of the rest of the site for cellar space. In this arrangement the exterior cofferdam provides a wall or dam against the exterior pressure of earth, water, and the effects of surcharge, and at the same time constitutes a support for columns located on the perimeter of the building. Interior columns in this arrangement are generally extended downward to a footing on hardpan or rock located below the general level for the cellar excavation.

A selection from the large number of available types should never be a matter of haphazard choice, and frequently not even one of judgment alone; the design should be determined only as the result of careful studies of every factor entering into the problem. Where the selected design involves, as it often does in downtown New York, four, five, or even six stories of basement space, the principal problem becomes not the supplying of vertical support to the structure, but the installation and maintenance of adequate lateral support for the basement walls. This is obtained by bracing the exterior walls, which must act as cofferdams against enormous outside pressures, including hydrostatic head, weight of materials, and surcharge of adjoining structures. There is also the very important matter of adequately supporting and underpinning the adjoining buildings whose foundations are not carried to rock, and assuring against movement of the streets. The engineer who attempts to evade his responsibilities by leaving decisions as to types, methods, and amounts of bracing, underpinning, and shoring to the foundation contractor, is, to say the least, remiss in his professional duties.

Too often the time element of an installation is considered as of secondary importance to, and as separate



SHEET PILE PIER CONSTRUCTION
Bank of Manhattan Company Building, New York, 1929
Steel Cylinders Supporting Old Building

from, its cost. Actually, they may be one and the same thing, and sometimes a saving in time has important financial value out of proportion to the cost of the work. Frequently an office building must be ready for occupancy on the first of May, and to miss this date may mean a year's loss of rentals.

The estimated first year's rentals from the Bank of

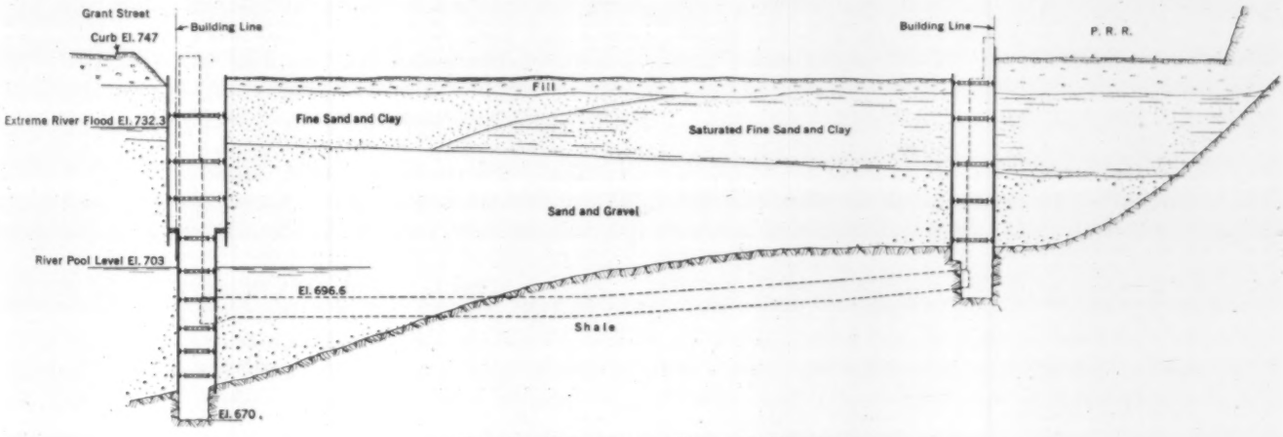
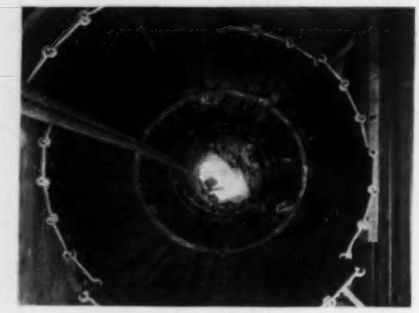


FIG. 2. PITTSBURGH FEDERAL BUILDING
Deep Open Cofferdam for Basement Construction

Manhattan Company Building at 40 Wall Street, New York, were so large that methods of installation were compared primarily as to their time requirements; and it was the time requirement which led to the development and successful installation of a type of foundation which was revolutionary for downtown New York. On the New Orleans Bridge, where bonds had to be sold for the entire project prior to the start of the work, interest charges on the bond issue were a controlling factor in the time schedule and methods proposed for the construction.



PIER OF CIRCULAR SHEET PILING SUNK TO ROCK
Addition to Bank of Manhattan Company Building, New York, 1930

Until recently, it was considered by those familiar with the subject that a deep foundation for a building in downtown New York must be on piers installed under compressed air. In fact it was commonly said and written that the development of adequate pneumatic methods had made possible the skyscraper of New York. The first pneumatic caisson installation ever used for a building foundation was for the old Manhattan Life Building at 66 Broadway. This installation consisted of steel sided and roofed working chambers with brick and mortar superimposed piers. This type was later superseded by the timber-sided and heavy timber-decked working chamber and brick pier; then came the concrete pier; and finally, the development of the monolithic concrete working chamber and concrete pier.

The desire for greater economy and the temptation of the owner to build cheaper and inferior types of foundations led finally to the development of open methods for deep piers and for cofferdam installations. Only a few years ago, in 1927, the first deep open foundation installation was made in downtown New York, and today it is the exceptional job which is designed for air pressure.

It has been my belief that the reason for the popular fear of quicksand is that builders have attempted to fight it rather than control it, or have not had sufficient respect for it. The proper treatment of quicksand is to drain it to prevent its movement. It is comparatively easy to demonstrate this method to engineers, but it remains difficult to convince the building public.

OPEN PIT FOUNDATIONS FOR HARRIMAN BUILDING

When my firm was employed for the Harriman Building at 39 Broadway, we were asked to provide a foundation at a cost which would fall within a budget allowance established on the advice of a foundation contractor that a certain type of pile could be installed to reach a bearing on bedrock. After borings of the subsoil disclosed a relatively thick layer of heavy boulders at a considerable depth above rock, we were convinced that the installation proposed was neither feasible nor safe. In fact, we refused to continue on that basis, and offered as a substitute which would meet the budget allowance for foundation costs, an open type of pier construction to bedrock. No foundation contractor would bid on this method, so we sent one of our inspectors to the site with a gang of laborers and excavated an open hole to rock in the deepest section of the lot, the hole being left open so that skeptical bidders could go down into it and see for themselves the success of the method employed. As a result, bids were obtained on the method proposed and a thoroughly satisfactory foundation constructed.

Again, on the Lee-Higginson Building, a contractor was found who was willing to attempt an open operation if relieved of responsibility. The method proved a complete success, with no recordable movement of adjoining buildings or adjacent street structures, and at a saving in cost of about 40 per cent. The departure from compressed air methods continues, and new open methods are still in process of development which will provide greater economies with no sacrifice of safety.

An interesting and difficult open cofferdam type of foundation is now being constructed for the Federal Building in Pittsburgh, where foundation walls are being carried to rock about 80 ft. below adjacent street level and 40 ft. below groundwater level, as shown in Fig. 2.

PROBLEMS OF BASEMENT SPACE

The advantage of studies of the economic questions involved in the production of available and valuable space below grade are best illustrated by the example of the Federal Reserve Bank and the Barclay-Vesey Telephone buildings in New York City. Both are located on ground of high value where building height is restricted. As the ground value increases, the amount of rentable space created within the building should increase, and in both these cases increased space beyond a fixed limit could be obtained only below ground. For each design studies were made which proved that the unit cost of cellar space steadily decreased as its volume increased, and that the entire space to bedrock could be obtained at the lowest comparative unit cost.

The foundation for a given building should not be accepted as the economically best type for a similar building with similar subsoil conditions; but each new major operation should develop newer, cheaper, and quicker methods, at the same time taking advantage of those previously developed. As an example; on the Federal Reserve Bank foundations, an efficient method of stressing the cross-lot bracing supporting the cofferdam was developed, which method for the first time avoided the inward movement of the cofferdam walls, and permitted the use of timber bracing at its economical working stress, rather than about 50 per cent of this stress, as had been the previous practice for such work.

This development was important because the Federal Reserve Bank's general excavation for its lowest cellar floor was about twice as deep as any previous operation, and because of the fact that directly across the street the heavy Mutual Life Building was supported on floating foundations and would have been seriously damaged had the cofferdam walls been permitted to move sufficiently to develop the stress in the cross-lot bracing which would be imposed on it by the lateral force acting on the exterior faces of the cofferdam wall. The concrete-walled pneumatic joint was also developed on the Federal Reserve job, since the depth of these joints considerably

exceeded the maximum for the old poling board method.

On the Barclay-Vesey Telephone Building, which immediately followed, permanent steel cross-lot struts were installed when the general excavation had been carried two-thirds of its entire depth, and this permanent support system was used also as part of the temporary system, thereby saving 50 per cent of the cost of an all-timber design.

Naturally foundations are frequently designed which are unnecessarily expensive, because of lack of confidence or lack of knowledge. Safety is a paramount consideration, and it is quite possible that many foundations are over- rather than under-designed. On the other hand, methods of design and construction have been greatly improved so that at the present time foundation structures can be built by much cheaper methods than those formerly used. There is, however, still room for improvement in design, if and when studies in soil mechanics demonstrate a sound basis for the calculation of stress effects in natural materials.

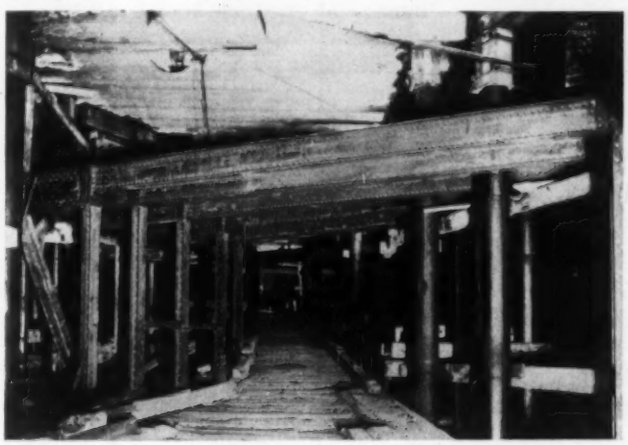
Supporting Subways in New York

By LAZARUS WHITE

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

PRESIDENT, SPENCER, WHITE AND PRENTIS, INC., NEW YORK

A TYPICAL example of a subway structure—one not in a deep tunnel, and not designed to carry future buildings—consists of from two to six tracks built within an excavation from 25 to 30 ft. deep and backfilled with from 5 to 10 ft. of earth. The backfill, containing conduits for various services, such as gas, water, and electricity, supports the street pavement. Such a



UNDERPINNING FOR THE WEST APPROACH OF BROOKLYN BRIDGE
Construction of Nassau Street Subway, New York

structure is commonly in the shape of a long box from 30 to 100 ft. wide, with a plain or reinforced concrete floor, the sides and roof being composed of steel bents, about 5 ft. from center to center, encased in concrete. Often the floor contains transverse steel beams which act as a foundation for the side walls and other columns.

This type of subway structure apparently has simple loading conditions—a live load of street traffic, usually assumed at about 500 lb. per sq. ft.; the dead load of the backfill, about 100 lb. per cu. ft.; the weight of the structure itself; and the live load of the trains.

With the loads known, it would seem a very simple problem to design the floor. From borings and other information, assume a bearing value for the subgrade material—perhaps with the aid of the local building code. Multiply this value by the width of the subway, and if the result exceeds the total load to be imposed on the subgrade, as it commonly will, the problem is solved except for the amount of steel to be added to the concrete floor. This also is simple if the pressure is assumed to be uniformly distributed over the subgrade.

Unfortunately, two uncertain factors enter into the problem—first, that of the effect of groundwater; and second, that of the non-uniformity of pressure on the base. A great deal of consideration has been given to the first factor, but as yet very little attention has been paid to the second.

PROTECTION AGAINST GROUNDWATER

In connection with the effect of groundwater, an important decision must be made as to whether or not to waterproof the structure. It was decided in the first subway built for New York—1900 to 1907—to completely waterproof the roof, sidewalls, and bottom, using for this purpose a membrane of several plies of asphalt and paper and, in exceptional places, layers of brick laid in waterproof mastic. The original subway was constructed by erecting structural steel bents of I-beams supported by side-wall columns, also of I-beams, and center columns of bulb angles and plates. Where the bottom was soft, a grillage of I-beams was used. The waterproofing was laid against a thin layer of "protection" concrete placed outside the steel bents, which, in turn, were encased in concrete arranged in the form of "jack arches." This design necessitated the calculation of the upward and lateral pressure of the groundwater, the level of which was assumed to be about 2 ft. higher than that found in borings, test pits, or excavation.

In one section along Broadway the waterproofing of the side walls was laid against hollow tile, which was connected at intervals to subdrains below the track floors. This drainage system functioned well until water from a broken water main found its way in great volume, through the hollow tile, into the drains. After lifting handhole covers, it flooded the track and caused stoppage of the trains.

In the New York subways which were built later, the use of hollow tile for backing of waterproofing was given up, as it was found that the tile keeps a layer of water continuously against the waterproofing. Such water absorbs various gases and liquids from the ground and is highly destructive to waterproofing. In many sections

of the later New York subways waterproofing has been omitted to a considerable extent—almost entirely in rock sections and on the bottom and sides above groundwater level. Waterproofing is still used for the roof, and in stations down to the platform level.

Unfortunately, the determination of groundwater level is not simple. The level depends upon the relation of supply of water to run-off through the ground, and this is necessarily highly variable. Because rainfall is diverted by pavements and buildings, groundwater in cities is replenished only by accidental leakage from water mains and infiltration from rivers and other bodies of water. Deposits of oil and sewage wastes on the bottom of streams and other bodies of water effectually seal off infiltration from that source, and detection of leaks in water mains makes this supply irregular. Furthermore, every excavation below the original groundwater level further depletes the supply, as does continuous pumping from below deep basements where waterproofing is either omitted or supplemented by drainage. Subways themselves affect the groundwater supply by acting as submerged dams, so that often the groundwater level is much higher on one side of them than on the other.

The uncertainties of the groundwater supply are well indicated by experience in New York, Boston, and other cities, where wooden pile foundations have rotted and failed although the tops of the piles were cut off below the original groundwater level. However, since the tendency is for the groundwater level to recede rather than rise, the use in design of the level found during the construction of the subway is usually on the safe side if the assumption of full upward groundwater pressure is used in the design.

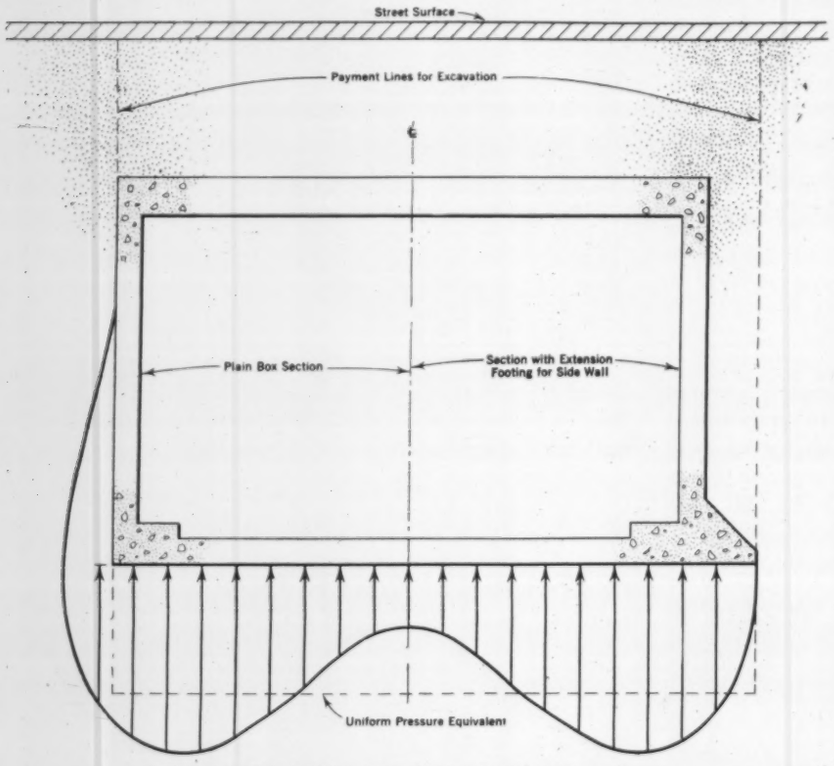


FIG. 1. REACTIONS BENEATH A SUBWAY STRUCTURE
Upward Pressure of Soil Is Proportional to Length of Arrows. Drawing Schematic Only, Not to Scale

When it is decided permanently to relieve the subway structure from groundwater pressures by means of a drainage system, the floor and side-wall construction can be considerably lightened. As far as I know, the only city in which this has been consistently done is Philadelphia, where the occurrence of comparatively fine sand and gravel offers rather favorable conditions. Drains laid below the tracks are connected at frequent intervals by Y's with transverse drains terminating in pockets of broken stone just outside the side walls. The longitudinal drains discharge into large sumps which are exhausted by batteries of automatic pumps set in specially built pumping chambers. At City Hall Station, where the subway is at a considerable depth, a large volume of groundwater has been pumped for many years.

As to whether it is better to waterproof or drain, many arguments have been advanced, both pro and con. Drainage saves much waterproofing, lightens the structure, and by lowering the groundwater level largely decreases the costs of neighboring foundation and basement construction. On the other hand, the pumping cost is continuous and some owners of structures built on wooden piles are put to much expense in reconstruction of foundations. There is also the question of the permanence and reliability of the drainage system.

In addition, there are legal aspects to the question of groundwater. In some places there are local regulations which endeavor to assure the permanence of groundwater levels. However, I know of no case where damage has been recovered by an owner because of expense incurred in reconstructing foundations damaged by lowering of the groundwater level, although several such cases have come into court. Without taking sides on the question of drainage versus waterproofing, I wish merely to state the case fairly so that designers can make a wise choice.

PRESSURE DISTRIBUTION ON SUBGRADE

The second uncertain factor, the distribution of pressure on the subgrade, has been over-simplified in the past by the assumption of uniformity of pressure over the entire base of the subway structure. However, because of the favorable shape of subways and their position, entirely buried in the ground, no failures of such structures are recorded. It might be asked then, why question the assumption and why not continue its use? There are two reasons: first, it does not give the most economical design; and second, since it is not sound, it may lead to trouble in the future. The new subways far outdistance the old in size and boldness of design, and the old precedents may not apply.

The typical subway structure, as previously described, has very favorable foundation conditions. It is long and relatively narrow, and completely buried, thus being relieved from variable wind and temperature stresses.

The weight of the earth dug out to make way for the structure is more than that of the structure itself, so that, according to the uniform pressure assumption, the subgrade would be required to carry no additional stress. This, however, is far from correct.

While excavation is proceeding, the earth at subgrade is undergoing various profound changes. When relieved of load it expands more at the center than at the sides; its moisture content and its temperature change; and to a certain depth it is affected by alterations in texture caused by working over it. Of still more importance is the fact that, when the subway is completed and backfilled, the subgrade is by no means uniformly weighted, but is loaded heavily at the sides and lightly in the center, somewhat as shown in Fig. 1.

The probable bulbs of pressure for this condition are shown in Fig. 2. According to this theory, the bending load on the floor is reduced, so that much lighter floors may be used than under the assumption of uniformly imposed pressure, thus effecting a considerable economy in design. A common practice, and a very expensive one, is to extend the side-wall footing beyond the outside of the wall, as on the right side in Fig. 1, with the purpose of securing balance and spreading the load more favorably. This has several disadvantages. It increases the width of cut adjacent to other structures, deprives the side walls of their frictional value, leaves a prism of unconsolidated backfill along the completed subway, and increases the cost.

If a subway excavation is carefully made, with tight side sheeting against which the concrete of the subway structure is cast, a great deal of foundation value is added free of cost. The modern method of driving vertical I- or H-beams so as to support horizontal wooden sheeting, which serves as a back form for the concrete of the side walls, is from the foundation point of view a very good one.

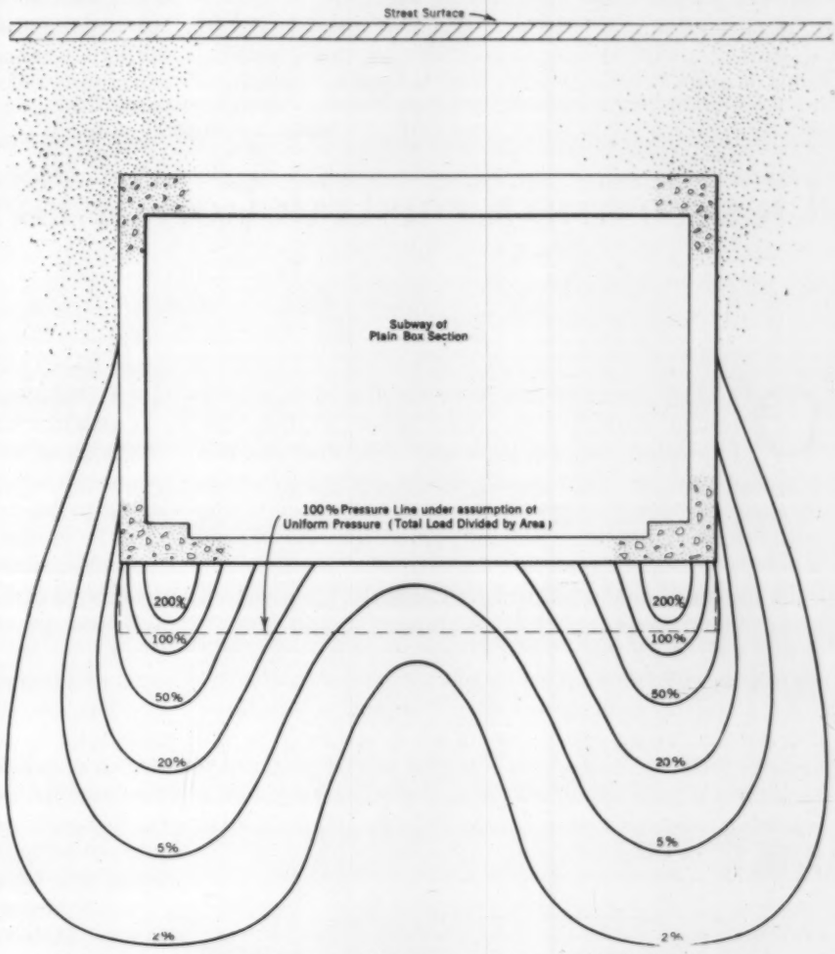


FIG. 2. DIAGRAM OF PRESSURE INTENSITY BENEATH A SUBWAY STRUCTURE
In Percentage of Average Pressure. Curves Change in Shape with the Proportions of the Structure and the Stiffness of the Floor. Drawing Schematic Only, Not to Scale

SPECIAL CASES REQUIRE INDIVIDUAL TREATMENT

Thus far I have merely discussed the typical case of a subway structure built in the street on ordinary ground—say, on ground good enough to safely support a five-story building on spread footings. But of course there are many special cases to be considered. Subways go under other subways, under existing buildings, and alongside other foundations but at a greater depth. They are also built to support high buildings to be erected over them, in order to conserve land values. These cases involve underpinning and special foundations, subjects apart from the scope of this paper.

There remains, however, the problem of a subway structure founded on very fine wet sand, or on alternating layers of sand and clay. In these cases are supplemental pile foundations desirable? This question was carefully gone into in connection with the Houston Street Subway in New York, when extensive investigations were made under the direction of the Corson Construction Company and the City Board of Transportation, as reported in a paper by George Paaswell, M. Am. Soc. C.E., and Glennon Gilboy, Jun. Am. Soc. C.E., read at a meeting of the New York (now Metropolitan) Section of the Society. It was decided to omit pile foundations for most of the work, using only steel tubes to rock at one end to support a future building, and steel tubes to sand under a heavy crossover at the other end.

Pile foundations for subways proper are seldom justified. However, there is one historic case where they were necessary. The original New York subway, in the neighborhood of Lafayette and Worth streets, crossed the old Collect Pond where Fitch had run his steamboat many years before. The pond of course had been filled in long before the subway construction. When the subway, which was built on a steel I-beam grillage, was observed to be settling rapidly, borings were made which disclosed peat, the worse possible foundation material, to a great depth below subgrade. Holes were cut in the floor and sections of steel pipe were jacked or driven through the peat, about 60 ft., to a hard gravel bottom and filled with concrete. The tops of the pipe piles were

concreted in, and the piles have been holding the subway safely ever since. This was the first time that steel pile underpinning was used on a large scale in a subway foundation. In the case of a subway built in squeezing clay, such as is found in Chicago, it may be necessary to take special precautions in exposing the subgrade material, and to make provision for uplift.

In conclusion it should be stated that much is still to be learned about subway foundations, as about foundations of other types. A large field is open for investigation and research, and the economies resulting from such researches will repay their cost many times. I believe that the testing of small-scale models will greatly help to reveal the true effect of uplift from groundwater and the exact distribution of pressure below subway structures.

It is to be hoped that the Society's Committee on Earths and Foundations will be able to do some research work along these lines and that public bodies charged with the design and construction of future subways will render aid to the committee.

Design and Construction of Bridge Foundations

By JOSEPH J. YATES
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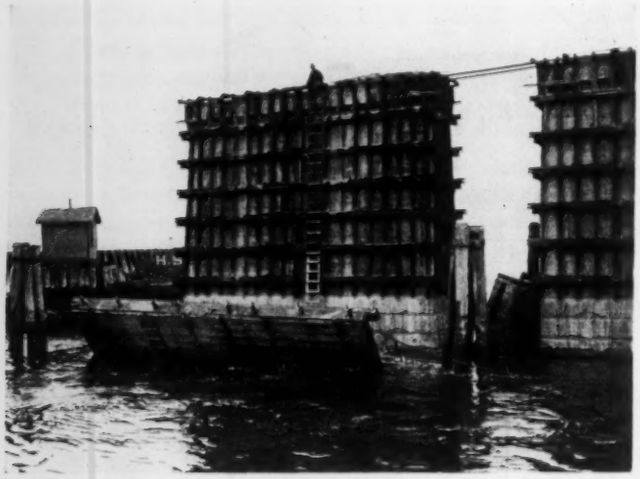
OF THE elements that comprise the design of a bridge, there is none more important than the foundation, nor are there any structural features of design that have as few established rules or practices to guide the designer in his choice of a type or in the establishment of safe working units for the design selected.

As the result of an extended experience in the design of bridge foundations I have found it necessary in investigating soil conditions to establish certain practices, which may be briefly summarized as follows:

1. Comparison of soil conditions at the site with those encountered under existing structures, generally in the same vicinity. Although this method will result in a safe structure, it gives no assurance that the resulting design will be economical, that is, that it will take full advantage of the soil bearing value.



REMOVAL OF CAISSON SIDES FROM A PIER, MAY 1924
Newark Bay Bridge; Jersey Central Railroad

2. Examination of soil conditions by wash borings. This method has little value in determining the character of the soil, but in soft material, where pile foundations are required, it offers an economical and generally reliable means of determining the length of pile needed and the depth to rock or hard material.

3. Examination of the soil by core borings, which are of particular value in determining the thickness of hard strata on which a foundation is to rest. It has been the practice to carry such borings at least 10 ft. into the rock strata to determine whether there are soft seams or voids in it.

4. Examination of the soil by test pits. Where conditions permit, this method is the one generally used, and it can usually be relied upon to disclose soil characteristics.

5. Examination of the soil by means of test loads to develop its safe bearing capacity. Where reliable comparative information is not available, it is the practice to resort to this method. In designing the foundation, one-half of the ultimate test load is used, with the further provision that up to three-fourths of it may be allowed for maximum toe pressure resulting from tractive force, and for wind, ice, and current pressures.

6. Examination of the bearing value of piles by test loads. Data thus obtained not only serve to determine the ultimate bearing-load value of a pile, but are particularly valuable in finding the horizontal resistance of the driven pile to overturning loads, and in soft soils in determining the extent to which the soil support can be depended upon to develop the pile as a column, all factors that have often been overlooked with disastrous results.

To determine the working loads for piles, it is the practice to use one-half the ultimate load value, although up to three-fourths of it may be allowed for maximum toe pressures resulting from tractive force, and for wind, ice, and current pressures, the same as in the case of ultimate test loads.

In making test loads on piles, a careful record is kept of the penetration per blow of the hammer so that when the desired test load has been reached, this record will serve as a guide in driving the foundation piles to a proper resistance. To determine what constitutes an ultimate load, the test loads are increased until settlement occurs, or until twice the unit load used in the design of the structure has been reached. In this test, a slight compression of $\frac{1}{2}$ in. or less is not considered as settlement except when it is progressive under the load applied.

7. It is the practice in tidal waters where conditions are similar to those in the harbor of New York, to keep all

timber in the foundations below mean high water and, preferably, below mean tide.

8. In designing foundations, the effect of the buoyancy of the water where present is not generally considered except when calculating the overturning resistance of the structure to horizontal forces, and then only in cases where the water has access to the base of the structure, such as in sand, gravel, or porous soils.

9. Near New York, the depth of foundations required to resist frost action is not less than 3 ft. below the ground surface. Frost is generally not a limiting factor, as the economical design of bridge abutments, retaining walls, and column footings, usually requires a spread footing, making necessary a greater depth to develop the design of the footing.

INVESTIGATION OF DESIGN

As regards soil bearing pressures, no method has been developed to determine by observation of soil characteristics the safe load that can be relied upon in all cases, although progress in this field is being made by various committees. The determination of the resistance of soils to pressure and their action under load opens a wide field for research, which will result in large savings in the design of foundations.

Foundation design is so intimately connected with the design of the structure and the method of constructing the foundation, that economy can only be secured by a correlation of these three elements—structural design, foundation design, and construction method.

In too many designs methods of construction have been ignored by the designers and left to the ingenuity of the contractor. In such cases the contractor is often compelled to use methods which may result in a greater total cost for the structure than would have been necessary if the designer had investigated and correlated the three features. A reinforced concrete design offers many economies but is largely dependent on foundation conditions and method of construction.

The generally accepted methods of calculating lines of pressure in foundations have been established through long practice and will result in an economical design, provided soil conditions are correctly interpreted.

A type of structure often incorrectly designed is the pier abutment with a fill carried around the ends and permitted to take its natural slope in front of the abutment, thus doing away with wing walls. In designing such structures it is my practice to ignore any value the earth fill in front of the abutment may have in resisting overturning and to limit the line of foundation pressure to the rear half of the foundation, obtaining an economic design by massing the weight of the structure as far back as practicable. The added load produced by a high fill will usually cause compression of the foundation soil, resulting in settlement of the structure. Where this type of abutment is used, the design must make adequate provision for such settlement.

Experience on a number of structures where this method was followed has fully justified its use. Movement has generally been confined to a small vertical settlement with a forward movement not exceeding 4 in. in the worst case, where the fill was nearly 40 ft. above the foundation base.

If a foundation is to rest on soil, the spread footing is a necessity and will result in a well balanced structure. It permits the full use of the reinforced abutment and retaining wall design and often gives large savings.

When water under a head of several feet is encountered in a foundation excavation it has been my practice to require the excavation—or the cofferdam, if used—to be

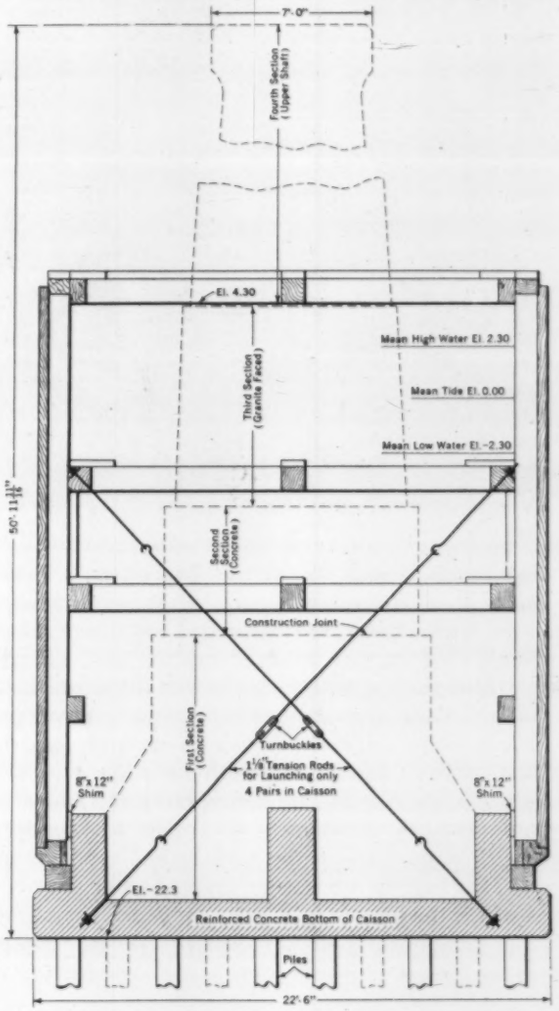


FIG. 1. SECTION THROUGH CONCRETE-BOTTOMED COFFERDAM FOR PIERS OF NEWARK BAY BRIDGE; JERSEY CENTRAL RAILROAD

made larger than the dimensions of the foundation so that the water can flow freely to the pump sump through channels outside the limits of the foundation. If the cofferdam is constructed of the same dimensions as the foundations, the depositing of the foundation concrete against it often results in disaster. At best a poor foundation is secured because of the disturbance of the freshly deposited concrete by the head of water created under the foundation course.

In designing foundations, the necessity of depositing concrete through water should be avoided wherever practicable. Even with the best construction methods, the results are questionable. I have had occasion to observe the removal of several foundations deposited by means of the tremie, in which the concrete of the foundation courses was badly stratified and so soft that it could be penetrated with a hand bar. On investigation it was found that conditions which obtained at the time this

concrete was deposited had made it impracticable to keep the tremie full at all times.

In pile foundations, concrete deposited through water around the pile heads often offers an economical means of sealing the bottom so that the structure can be constructed in the open. While I do not wish to condemn the depositing of concrete through water by either the tremie or the drop-bottom bucket, I do desire to call attention to the danger involved and to emphasize the necessity of requiring skilled supervision if this method is resorted to. Careful study should be given to developing methods by which the depositing of concrete through water can be avoided. In several foundations where the bottom was so porous that it was impracticable to control the water and prevent damage to the freshly deposited concrete, I have bagged the foundation concrete and deposited the bags in interlocked layers to a height above that at which the water could be controlled. An efficient and often economical method recently developed consists of lowering the groundwater level around the foundation by the use of well points.

SLIP WAYS FOR CONCRETE-BOTTOMED FLOATING CAISSONS
Pier Construction, Newark Bay Bridge; Jersey Central Railroad

Many of the preceding observations in regard to foundations on dry land are applicable to foundations under water. As their application is evident it will not be necessary to repeat. When a foundation in water is to rest on soil, it is generally constructed by means of cofferdams or pneumatic caissons, or by settling an open cellular caisson by dredging through the wells.

Foundations constructed of concrete or wood piling are common along sea coasts and rivers, where soft soils are generally encountered. Piles offer an economical method of building a foundation in compressible soils. Their safe bearing value is seldom utilized, for engineers are prone to assign low values rather than go to the expense of making tests. On small structures this course is no doubt justified, but on costly ones an investigation of the bearing value of piles and their resistance to horizontal loads is desirable and will generally result in large savings. It is evident that a pile driven through hard material, to such refusal as will not result in damage to the pile, is safe for a much greater load than one driven to the same refusal through soft strata, owing to the greater lateral support afforded by the harder material.

Where foundation piles will always be below the water level, wood piles are generally the most economical. However, when the pile cut-off is above water, the concrete pile is necessary and will in many cases result in a saving as compared with the alternative of carrying the foundations to the water level and using wood piles.

It has been my practice to carry the foundation concrete to a point one foot below the cut-off of the piles to make certain that they will act as a unit in resisting horizontal loads. Where pile foundations are in shallow water, the structure may be constructed economically by means of open cofferdams, but where deep water is encountered it is generally more economical to sink floating caissons on the piles, which have previously been cut off to the proper level.

In water depths of as little as 10 ft., a substantial saving can often be made by driving the pile head under water to the approximate cut-off, either by means of a follower or by the use of the under-water hammer. The piles can then be cut to the desired level by a saw mounted on a vertical shaft and operated from a floating barge or fixed platform. In cutting off piles under water, much labor and trouble can be avoided by using timber that will float, so that the tops of the piles, when cut off, will come to the surface and not become lodged between the piles and foul the saw.

Experience has shown that the spacing of foundation piles should be not less than 2 ft. 6 in., center to center, in order to permit proper driving. A short pile is of little value unless it is to be driven through reasonably hard material to rock or hardpan. The specifications should require that foundation piles have a penetration of at least 15 ft., and it is often found necessary to require jetting in order to obtain this minimum requirement.

Floating caissons are generally constructed with either a timber or concrete bottom and detachable wooden sides, which can be removed after the caisson has been settled on the piles and the pier construction has been raised to a point above high water. Where practicable, there is a decided saving in using a concrete-bottomed caisson in construction requiring a number of piers of the same design. In the case of a wood-bottomed caisson, the maximum pile load is governed by the strength, across the grain, of the timber bottom, but with the concrete bottom the safe load is limited only by the with-the-grain strength of the pile itself. Thus, where soil and driving conditions are favorable, the concrete bottom permits a much higher bearing load.

The advantage of the wood-bottomed caisson is its low cost of construction. Concrete-bottomed caissons must be constructed on shipways and launched, but the wooden ones can be built floating on the water. The use of wood bottoms is economical for structures which require only a few piers, where the cost of shipways would more than offset the lower cost of the concrete bottoms.

In conclusion, attention should be called to the great progress that has been made since the World War in the development of methods of constructing foundations, especially in the case of those built by means of pneumatic caissons, where large economies have accrued from the high degree of development that has taken place in design. It is important that careful consideration be given to these modern construction methods.

Ship Dimensions and Bridge Clearances

ACCORDING to the Constitution of the United States, navigable waterways are under Federal jurisdiction. Congress has delegated to the War Department the control of the construction of bridges over them. As the size of water-borne craft has increased steadily year after year, the approved clearances of bridges, both horizontal and vertical, have been correspondingly raised. Up to the present time many millions of dollars have been spent to provide the clearances required by the War Department for the convenience of navigation. In the two papers that follow, read on January 20, 1932, before the Engineering-Economics and Finance Division at the Annual Meeting of the Society in New York, stress is laid on the necessity of limiting the vertical dimensions of ships. In the first paper, Mr. Grunsky states his conclusions that a maximum vertical clearance of 175 ft. is ample for bridges located below seaports, and that masts in excess of this height should be made collapsible or shortened. In the second paper, Mr. Wheeler recommends that Congress give the War Department jurisdiction over the dimensions of vessels operating on the navigable waters of the United States so as to secure their conformity with reasonable bridge clearance requirements, thus relieving the taxpayers of the country of a great burden.

Required Clearances Below Seaports

By C. E. GRUNSKY

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A YEAR or more ago an advisory board made up of two representatives of the Corps of Engineers of the U.S. Army, two admirals in the Navy, an engineer from the staff of the California State Highway Department, and three other civilians, in passing upon the location and main features of a bridge across San Francisco Bay from San Francisco to Oakland, recommended a vertical clearance of 214 feet.

Apparently this recommendation has been accepted without question by the state authorities who are now working on plans for the structure. Neither San Francisco nor Oakland has entered any protest against this excessive height, undesirable though it is, both from the standpoint of cost and from that of the decreased stability of the structure. Why, then, in such cases as this, as also in the case of the proposed bridge across the Hudson River at 57th Street, New York, should there not be some reasonable standard requirement, some

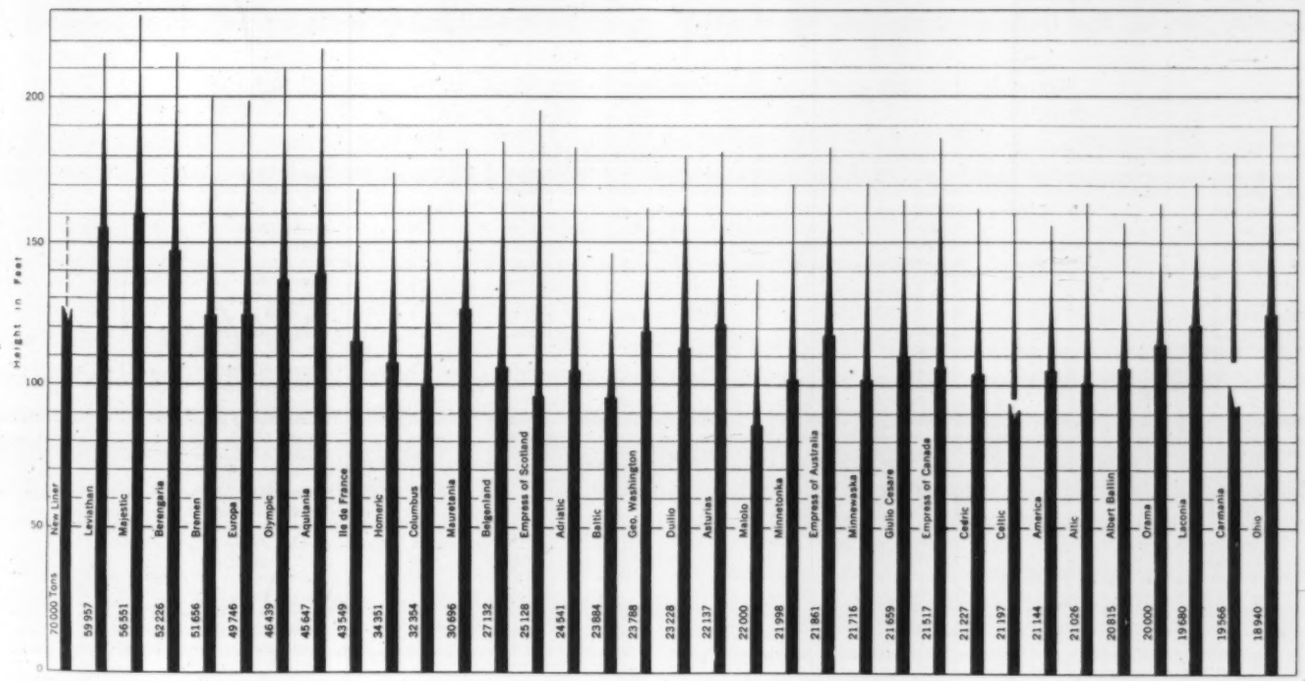


FIG. 1. HEIGHTS OF FUNNELS AND MASTS OF THE LARGEST OCEAN-GOING SHIPS

international declaration that no bridge across maritime waters with a specified standard clearance above extreme high water will interfere with any port development?

In the case of railroad construction, tunnels are built with due regard for a standard minimum clearance, to which the dimensions of rolling stock as well as of car loadings are adjusted as a matter of course. There should be a declaration by some international group of those engaged in ocean commerce that some particular reasonable vertical clearance under bridges will not interfere with port development. As a matter of course, funnels and masts of ships thereafter built would be made to conform with this regulation. Moreover, the ships already built with funnels and masts higher than the standard would, if necessary to secure cargo, quickly make such alterations as would permit them to pass under all bridges of the regulation height.

I find no evidence to indicate that, for the present, any other considerations than the demands of commerce, the willingness of the traveling public to pay for room, comfort, and luxuries, and the facilities of the ship builders will limit the size of ocean liners. In other words, if the deepening of harbors and harbor approaches is continued without restriction, the size of ocean liners will, under otherwise permanent conditions, continue to increase. Unless checked by the withholding of Government subsidies or other similar expedients, the ocean-going ship may be built to any size compatible with economy of operation and the demands of commerce. However, only those ports that can hope to be favored by visits from the largest ships find it worth while to provide suitable harbor and berthing facilities for them.

LIMIT DIMENSIONS OF OCEAN-GOING SHIPS

The dimensions of the largest ocean-going vessels therefore exert a strong influence on the concentration of the export and import business at certain points, such as New York Harbor, where nature has made possible the construction of the facilities demanded by the ship owner who wants to operate vessels of the largest size compatible with safety and speed. It is to the interest of other ports not so well favored by natural conditions that some artificial limit be set to the size of the ocean-going ship, particularly in the matter of draft, in order that harbor improvements may be planned with a reasonable certainty of permanent adequacy. In view of these circumstances there should be some international understanding concerning the depth of water at low tide to which the important harbors of the world should be improved. Furthermore, there should be no Government aid, in the form of a subsidy or other encouragement, to vessels whose dimensions are such as to make their entrance into a harbor of standard depth impossible.

It would be unwise, for example, for the United States to encourage, by subsidy or otherwise, the construction of vessels too large to pass through the locks of the Panama Canal. In time of war, the usefulness to the Government of any particular ship depends on its adaptability to the requirements of the moment. A ship should be large enough and yet not of such colossal dimensions that it cannot make port at some unforseen new destination.

By the construction of the Panama Canal, the United States has practically set a limit to the dimensions of vessels whose construction can be encouraged by the Government. The canal and its lock system cannot be easily modified. The usable size of the locks—1,000 ft. long, 110 ft. wide, and 41.5 ft. deep on the sills (equal to 40 ft. of salt water)—has fixed the maximum dimensions of both war vessels and others which are likely to be constructed by the United States or by any American owners with Government aid.

For a number of years the Leviathan, a 60,000-ton ship, and the Majestic, with a tonnage of 56,550, have been the largest ships afloat. The Cunard Steamship Company has partly constructed an ocean liner of 73,000 tons. Ships materially larger than these are not likely to be built, and if they are it will be for use on special

TABLE I. HEIGHTS OF FUNNELS AND MASTS OF THE LARGEST OCEAN-GOING SHIPS

VESSEL	TONNAGE	LENGTH	BEAM	DRAFT LOADED	HEIGHT OF FUNNEL	HEIGHT OF MAST	OWNER
New Liner (1932)	73,000	...	...	..	...	...	Cunard Steamship Company
Leviathan	59,957	907	100	..	150	215	United States Lines
Majestic	56,551	915	100	39	160	228	White Star Lines
Berengaria	52,226	919	98	38	147	215	Cunard Steamship Company
Bremen	51,656	939	102	35	114	200	North German Lloyd
Europa	49,746	935	98	35	114	199	North German Lloyd
Olympic	46,439	852	93	34	137	210	White Star Lines
Aquitania	45,647	869	97	..	139	217	Cunard Steamship Company
Ile de France	43,548	...	..	..	114	158	French Lines
Homeric	34,351	751	83	36	108	174	White Star Lines
Columbus	32,354	774	83	34	100	164	North German Lloyd
Mauretania	30,696	762	88	..	126	182	Cunard Steamship Company
Belgenland	27,132	670	78	36	106	175	International Navigation Company
Empress of Scotland	25,128	677	77	34	96	186	Canadian Pacific Lines
Adriatic	24,541	709	76	37	105	173	White Star Lines
Baltic	23,884	709	76	37	96	146	White Star Lines
George Washington	23,788	699	78	..	119	162	United States Lines
Duillio	23,228	602	76	30	112	180	Italian American Shipping Corporation
Asturias	22,137	630	78	31	121	181	Royal Mail Line
Malolo	22,000	582	83	..	87	138	Matson Navigation Company
Minnetonka	21,998	601	80	..	102	170	Atlantic Trans. Company, Ltd.
Empress of Australia	21,861	590	75	29	118	184	Canadian Pacific Steamship Company
Minnewaska	21,716	601	80	37	102	170	Atlantic Trans. Company, Ltd.
Guilio Cesare	21,659	602	77	30	110	165	Nav. Gen. Italiana
Empress of Canada	21,517	627	78	29	107	187	Canadian Pacific Steamship Company
Cedric	21,227	700	75	..	114	162	White Star Lines
America	21,144	669	74	33	106	157	United States Lines
Altic	21,026	681	75	36	101	164	White Star Lines
Albert Ballin	20,815	602	79	33	107	158	Hamburg American Lines
Orama	20,000	632	75	29	114	165	....
Laconia	19,680	600	74	32	121	171	Cunard Steamship Company
Carmania	19,566	...	..	..	...	181	Cunard Steamship Company
Ohio	18,940	591	72	31	126	190	Royal Mail Steam Packet Company

routes. The heights of funnels and masts of the large steamers built for special routes deserve only secondary consideration when bridge clearances are to be prescribed for other navigable waters. Furthermore, it is highly undesirable that, in order to save a few thousand dollars in adjusting the height of the top parts of even the largest vessels now afloat, the clearance of fixed bridges should be made unreasonably high.

CONSTRUCTION HINDERED BY CLEARANCE REQUIREMENTS

Suppose, for example, that a bridge over The Narrows below New York should be authorized with a clearance of 175 ft. above extreme high tide. It would then be necessary to alter the masts of the Leviathan and some thirty other steamers, and of an unknown number of sailing vessels. This could readily be done without detracting from their usefulness and but little, if at all, from their appearance. The builder of such a bridge undoubtedly would prefer to pay any expense involved in lowering masts, rather than to provide additional vertical clearance for the bridge. If there were such a bridge, or if construction of such a bridge were seriously considered, all new ships, whether steamships or sailing vessels, would be given such top parts that they could pass under it without inconvenience.

It will of course be contended that ships have the right-of-way and that every fixed bridge over navigable maritime waters should have a clearance such that ships with the highest masts, present and prospective, can pass under it without even the slight inconvenience of housing or lowering their top masts. It is this view that has prompted such organizations as the Ship Owners Association of the Pacific Coast to demand a vertical clearance of 250 ft. for the San Francisco-Oakland Bridge. Such demands are in most cases equivalent to saying that there should be no bridge. It is a rare case in which topography downstream from major ocean ports favors a high bridge. As a general rule, the banks of navigable maritime waters are low, and high bridges must have long approaches. It follows that each additional increment of height adds materially to the over-all length of the bridge, and therefore proportionately more to its cost than the expense of making the piers higher. Large sums may also be required in giving adequate stability to an excessively high bridge.

In conclusion, it seems obvious that there is somewhere a point at which the demand for higher vertical clearances should stop, even when provision must be made for ships of the largest dimensions. To determine this point, a study has been made of the heights of funnels and masts of all ships rated at over 10,000 tons. The results of this work, in so far as they relate to ships with a tonnage down to somewhat less than 20,000, have been platted in Fig. 1 and are presented in Table I.

It appears from a consideration of these data that there is no ship afloat with a funnel higher than 160 ft. (when the ship is light) but that there are numerous ships with masts that exceed this height. In fact there are three or four ships whose masts rise to a height of 220 ft. or more.

VERTICAL CLEARANCE OF 175 FT. AMPLE

In view of the fact that such high masts serve mainly for ornamental purposes and also that they could be readily cut down or made collapsible to some specified height of but little above 160 ft., the conclusion seems inevitable that a minimum vertical clearance of about 175 ft. for bridges located downstream from important ocean ports, would not interfere with commercial activities or prevent in any measurable degree the full development of the port.

There should now be obtained from some such organization as the International Association of Navigation Congresses a declaration to this effect. All future large ships would then without question be so dimensioned that they could pass under bridges of 175-ft. (53 meters) clearance. If this were done many local problems of bridge design would be greatly simplified.

Legal and Economic Phases

By WALTER H. WHEELER
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
DESIGNING AND CONSULTING ENGINEER, MINNEAPOLIS

IN INTRODUCING this subject, I quote from the address delivered at the St. Paul Meeting of the Society in October of last year by Francis Lee Stuart, then President of the Society. He said, "If we could eliminate some of the artificial restriction and class legislation and political diseases which beset us, and reduce taxation instead of increasing it, and revert to the laws of supply and demand in business, it would be a hopeful sign for a new era."

It might be added that waste is one of the great enemies of civilization, and that it is one of the engineer's hardest tasks, as well as one of his most profound duties, to banish it from the world. Applying this principle to construction problems, it may be said that the engineer has done his best work when he has achieved maximum economy in first cost, without sacrificing any of the other necessary or desirable qualities.

In the matter of bridge clearances, it may be considered that the engineer has best served the interests of all concerned when the clearance requirements and the benefits to be gained by them have been nicely balanced against the cost of securing the clearances, or of making provision for securing them at some future time, should the need arise. Generally speaking, bridge clearances for navigable or potentially navigable waters are determined in the interest of navigation, and have resulted in increasing the total cost of bridges in the United States many millions of dollars.

Obviously, increased bridge costs must be reflected in higher taxes and transportation rates. The general public does not seem to realize that the consumer pays the taxes, and not the corporations or individuals owning the bridge property who hand over the consumer's money to the tax collector. If the people fully understood the situation, doubtless more thought would be given by our tax-collecting and tax-spending bodies to the reduction of bridge costs.

The following questions are submitted for the consideration of the members of the Society in the hope that they may stimulate discussion and eventually aid in bringing about a more equitable solution of the problem.

1. Do we need, or is there any reasonable expectation that we will need in the future, such bridge clearances as are now required by the Federal authorities to protect the navigation interests?
2. Is it justifiable to require heavy expenditures of tax money for long, high spans, or for movable spans of large dimensions—or in fact for any movable spans—over waters which are not now used for commercial navigation and which may not be so used for many years?
3. Would it not be better engineering and sounder economics to provide clearances which will accommodate modern towboats and barges, and let the owners of the old fashioned river steamers, with their high stacks, modernize their boats to conform with such clearances?
4. Shall we require that rivers be bridged with single spans at high levels, thus increasing the cost of such crossings by hundreds of thousands, and even millions of dollars in some instances, or shall we permit piers that allow ample space for the safe passage of vessels, and then safeguard these piers by means of suitable and comparatively inexpensive cushions or buffers which will take up the force of a collision, if one should occur?
5. What are the legal rights of the parties concerned, and should there be come corrective legislation? If so, along what lines?
6. How do bridge clearances in the United States compare with those in foreign countries?
7. What are the military aspects of the problem, and how does it concern our system of national defense?

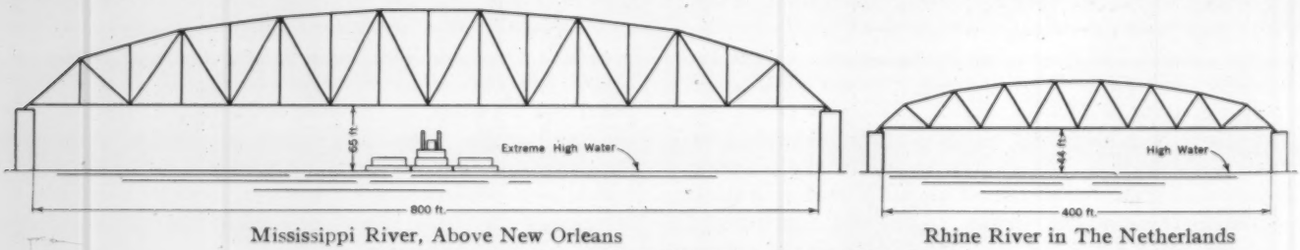
WAR DEPARTMENT CONTROLS BRIDGE CLEARANCES

According to the Constitution, the navigable and potentially navigable waterways of the United States are under the jurisdiction of the Federal Government. Congress has enacted legislation which delegates to the Secretary of War and the Chief of Engineers of the U.S. Army authority to control the construction of bridges over navigable waters in the interest of navigation. But there has been no legislation to control or regulate the dimensions of the boats using these navigable waters, to prevent the placing of unreasonable burdens upon the taxpayers and the private owners of bridges.

Of the bridge legislation enacted by Congress, the act of March 23, 1906 is possibly most interesting to the bridge engineer. It provides that when authority is granted by Congress to any persons (the word persons is here used to mean any party or parties) to construct and maintain a bridge across or over any of the navigable waters of the United States, such bridge shall not be built or commenced until the plans and specifications for its construction, together with such drawings of the proposed construction and such map of the proposed location as may be required for a full understanding of the subject, have been submitted to the Secretary of War and to the Chief of Engineers for their approval, or until they shall have approved such plans and specifications and the location of such bridge and accessory works. When such plans have been approved, it shall not be lawful to deviate from them, either before or after completion of the structure, unless the modification has been first submitted to, and approved by, the same authority. It should also be noted that the Secretary of War has authority to require changes in existing bridges that have been authorized since the date of this act.

By court decision, the term, "navigable waters of the United States," applies, first, to all waters capable of sustaining, or of being used for, interstate or foreign commerce, including every part of any body of water, tidal or otherwise, of which any portion is capable of such use. A "navigable stream" in the broad sense "is a stream such as will permit and bear the passage of ordinary boats of commerce upon the bosom of its waters." A private canal connecting with navigable lakes or rivers is within the jurisdiction of the United States when used for commerce. A bridge constructed over a navigable river in accordance with an act of Congress is a lawful structure, no matter how much it interferes with navigation. The United States courts have jurisdiction in equity to require the removal of a bridge over navigable water, although it has been authorized by statute of the state in which it is situated.

In general, if the navigable waters which are to be bridged lie wholly within the boundary of one state, it is not necessary that the bridge be authorized by act of Congress, but it must be authorized by act of the legislature of the state in which it is situated. It is also necessary that the plans and specifications be approved by the Secretary of War and the Chief of Engineers. When a bridge is authorized by act of Congress, its actual construction must begin within one year of the date of the act, and it must be completed within three years of this date. In the act of March 23, 1906, the right is reserved to alter or repeal an authorization, and the United States is held not liable by reason of any such change.



Mississippi River, Above New Orleans — Rhine River in The Netherlands

FIG. 1. GRAPHIC COMPARISON OF REQUIRED BRIDGE CLEARANCES

By the act of August 11, 1888, the owner of a bridge is made liable to riparian owners for damage which may be caused to the river banks as a result of the deflection of the current by the piers or abutments of the bridge. Unless the bridge owner protects the river banks, as directed by the Secretary of War, he becomes liable for double damages.

SHIP DIMENSIONS SHOULD BE CONTROLLED

It is clear that whether navigation is reasonably free, easy, and unobstructed through or under a certain bridge, depends upon the dimensions of the water craft in use there. No specific authority is given to regulate the dimensions of water craft. If Congress, using its powers under the Constitution, would also delegate to the Secretary of War and the Chief of Engineers the authority to require water craft to conform to reasonable bridge clearances, so that the bridging of our rivers would also become reasonably free, easy, and unobstructed, much good might result, and the public might be relieved of part of the present high cost of bridging navigable waters.

Exclusive of the Great Lakes waterway system, the revenue freight transport on the rivers and canals of the United States in 1920 was 125,400,000 tons, valued at $2,814,600,000. By 1929 this amount had increased to 245,894,000 tons, valued at $3,871,300,000. In 1920 the railroads of the United States carried 2,259,983,278 tons of revenue freight, which in 1929 had reached the amount of 2,451,601,084 tons. In addition, the railroads carried 786,432,468 passengers in 1929, whereas the number of passengers transported on rivers and canals was by comparison very small.

I have no comprehensive statistics to show the total freight and passenger traffic on the highways of the United States, but unquestionably it is very large. Some published estimates indicate that the freight tonnage moved by truck is greater than that moved by rail, although the ton mileage is estimated at only about 5 per cent of the railroad ton mileage.

From the figures given, it is clear that the commercial importance of the railroads and highways as carriers is many times that of the waterways. I do not wish to belittle the commercial importance of the latter, but merely to point out the relative importance of land and water transportation as one good reason for extending the control of the Secretary of War to include jurisdiction over the dimensions of water craft as well as over those of bridges.

BRIDGE CLEARANCES ON THE MISSISSIPPI

In the discussion that follows, I have confined myself largely to the Mississippi River and its tributaries, since space will not permit of an extensive survey. The vertical and horizontal clearances in the main spans of the fixed bridges over the Mississippi from New Orleans to the temporary head of navigation at Minneapolis are as follows:

District	Vertical Clearance Above Extreme High Water In Feet	Horizontal Clearance In Feet
New Orleans to Cairo	62.6 to 63.8	684 to 800
One bridge at Vicksburg	56.6	800
Cairo to the Eads Bridge	62.5	647
Eads Bridge to the Illinois River	47.6 to 58.3	400 to 520
Illinois River to the Washington Avenue Bridge, Minneapolis	43 to 107.3	160 to 640

At the present time the vertical clearances above extreme high water that are being adhered to are 65 ft. below the Eads Bridge at St. Louis, and 50 to 55 ft. above the Eads Bridge. There seems to be a tendency to increase the horizontal clearances on the Mississippi River. I understand that a horizontal clearance of 750 ft. has been asked for a proposed bridge over the Mississippi River at Hastings, Minn. There are three bridges at St. Louis which have vertical clearances of less than 50 ft.—the Eads Bridge, which has one of 48.1 ft.; the Salisbury Street Bridge, with one of 47.6 ft.; and the Ferry Street Bridge, with one of 44.8 ft. There is a wide fluctuation (approximately 40 ft.) in the height of the river at St. Louis, so that during most of the time the vertical clearance on these bridges is much greater than the minimum required for other bridges. Between the Illinois River and the head of navigation at Minneapolis, there are 22 fixed, and 23 movable, bridges over the Mississippi. There are fewer bridges below the Illinois River than there are above it. The clear openings of the movable bridges above the Illinois range from 152.1 to 315 ft. except for a pivot drawbridge at Hastings, Minn., which has one 100-ft. opening and one 130-ft. opening.

A list of the boats in service on the Mississippi River in the St. Louis district shows the following minimum and maximum clearance requirements, in feet:

Number and Class of Boats	Height of Top of Pilot House Above Water	Height of Top of Stack Above Water	Height of Top of A-Frame Above Water
36 towboats	19 to 46	30 to 65	.....
22 dredges	31 to 46	39 to 69.5	34 to 54.5
10 derricks	.....	28.5	34.5 to 64.5
5 excursion boats	52 to 61	59 to 65	.....
4 packet boats	48.5 to 52	52 to 57	.....
2 pile drivers	.....	.....	42 to 60
2 snag boats	36 to 49	41.5 to 69	.....
Typical large towboat	33	.....	.....

The height of the pilot house is governed to a considerable extent by the pilot's requirements for clear sight over the top of the barge tow. A typical large tow is about 735 ft. long, measured from the pilot house on the towboat to the front end of the forward barge. It is customary to carry the tow ahead of the towboat. The clear sight over such a tow, from the typical pilot house which requires a vertical clearance of at least 34 ft., is about 400 ft. ahead of the forward barge when the barges are loaded, and about 900 ft. when they are running light.

COLLAPSIBLE STACKS ADVISABLE

Stacks and radio masts can be made to fold and be lowered to pass under bridges. Derricks, dredges, and pile drivers do not travel as extensively as towboats, and

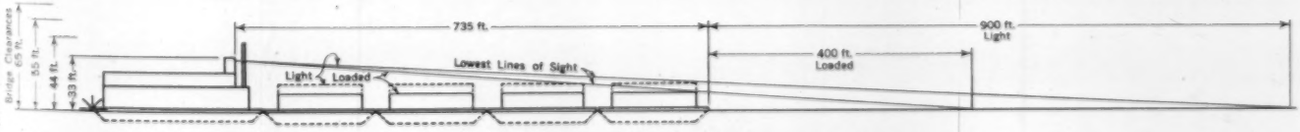


FIG. 2. MINIMUM SIGHTING DISTANCES OF TYPICAL LARGE TOW
Light and Loaded Barges on the Mississippi River

the A-frames of such boats might be made to fold down when necessary. It would also seem that the inventive genius of America might devise a pilot house which could be raised and lowered by power. When towing cotton or other bulky commodities, the pilot could raise the pilot house to the required height and then lower it long enough to pass under low bridges in times of high water.

Excursion and packet boats form such a small part of the river traffic that they could be built to conform to the clearances required for towboats. Since the cost of the equipment suggested would be comparatively small, it would not unduly burden the owners of these boats. It seems much more equitable to ask them to spend a small amount in equipping their boats so that they can operate under lower bridges during the infrequent periods of high water, than to build all the bridges to suit the convenience of all river navigators.

The amount of freight moved across the Dutch border on the Rhine River in 1926 was approximately four times the amount carried on the entire length of the Mississippi in 1929. However, the longest spans for fixed bridges over the main channel of the Rhine in the Netherlands are about 400 ft., and the greatest vertical clearance above high water is 44 ft., as compared with fixed spans of 800 ft. and required vertical clearances of 65 ft. above extreme high water on the Mississippi River below the Eads Bridge, and those of from 50 to 55 ft. above it.

It is hazardous to make general statements concerning bridge costs. Generally speaking, however, it may be said that one clear span of 800 ft. will cost from two and one-half to three times as much as two 400-ft. spans. A double-leaf bascule with a horizontal clearance of 250 ft. will cost about twice as much as a similar bridge with a horizontal clearance of 160 ft.

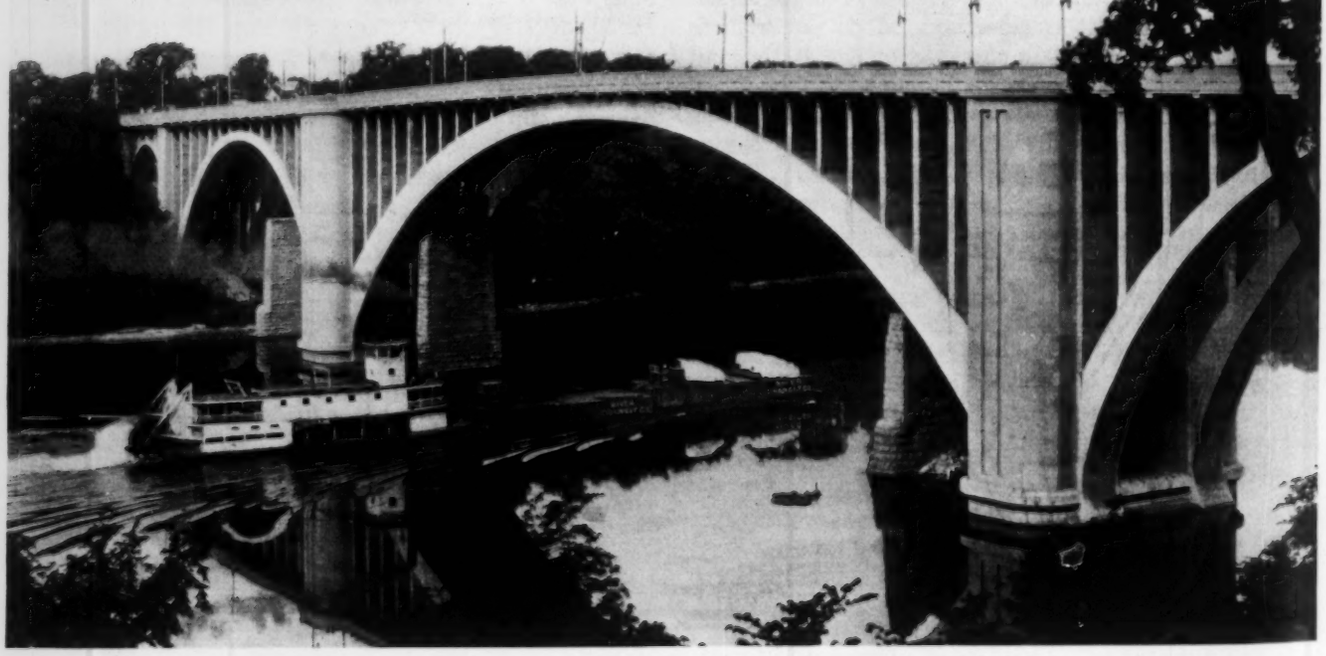
From this brief survey it is apparent that a great many extra millions of dollars have been, and are being, spent for bridges in the United States to provide the horizontal clearances required by the War Department for the convenience of navigation. It is more difficult to make general observations of the effect of vertical clearance requirements. Much depends upon the natural conditions at the bridge site. I believe that it would not be difficult to show by specific examples that the vertical clearance requirements have also added materially to the cost of bridging navigable and potentially navigable waters, and that they have made it impractical to use bridge sites which would otherwise have been very desirable.

The War Department is showing a tendency to be somewhat less exacting in its requirements for movable spans on rivers which are not now navigable in a practical sense, although considered to be potentially navigable. It is my understanding that in some cases they are permitting the installation of fixed spans, which may be converted into movable spans when actual navigation develops, and this is a step in the right direction.

From the military point of view there is much to be said in favor of short-span, as compared with long-span, bridges. The total destruction of a long-span bridge would surely be easier than that of one consisting of a number of short spans. Likewise, the cost of replacing a short-span bridge is much less, and it can be done in a much shorter time.

I repeat that I do not wish to belittle the importance of navigation, but it does seem that greater bridge clearances have been required than practical considerations and sound economics will justify for either the present or the predictable future. I suggest that the Society committee which is considering bridge clearances over navigable waters give thought to the advisability of going into this matter more fully and of asking for legislation which will enable the War Department to exercise greater control over navigation in the interest of bridge owners and taxpayers.

In closing, appreciation is expressed for the fine cooperation given me by the various district offices of the U.S. Corps of Engineers that have furnished data used in this paper, to the Engineer Corps of Canada, and to J. P. van Bruggen, City Bridge Engineer, Rotterdam.



TYPICAL MISSISSIPPI BARGE AND TOW UNDER THE CAPPELEN BRIDGE, MINNEAPOLIS

What Are the Facts?

Engineers Called Upon to Supply and Analyze Statistics on Production and Consumption of Power

By George Otis Smith

Chairman, Federal Power Commission, Washington, D.C.

SECRECY irritates the public mind, especially when the unknown facts have to do with the operations of industry and public utilities. In this abstract of his paper presented before the Power Division on January 21, 1932, at the Annual Meeting of the Society in New York, Dr. Smith states that in public discussion of the power issue the need is for facts and facts clearly analyzed and presented in terms understandable to the average citizen without technical training. Power companies should make their data public if they hope to correct the impression that the spread between the cost of production and the price charged the ultimate consumer is all profit.

WHAT are the facts? This is the question that should be uppermost in any discussion of the power issue. It is a question that should be put before the engineering profession. In particular, members of the Society will realize the need of facts in solving any problem and will appreciate not only their inherent value and everyday usefulness but also what might be termed their inviolate nature. Facts are sacred things.

The wider the public interest in any topic the greater the incentive to lead the discussion into devious paths. This danger is especially evident when the issue involves large corporations, for then public suspicion is easily aroused and legislative scrutiny is urgently demanded. Then also, public opinion on the question finds its chief expression under auspices not wholly favorable to the discovery of the truth. Certain restrictive channels for the spoken or written word—whether restrictive for political or commercial reasons, it matters not—are too likely to be selective in action.

NEED FOR OPEN FORUM EMPHASIZED

The open forum that provides best opportunity for free presentation of the facts is the engineering society. The idea is not new; indeed, it was part of the purpose that lay behind the organization of these great national bodies of technical men. And I have in mind an appeal for the larger use of this forum that was made 25 years ago by James Douglas, the mining engineer perhaps best known as the creator of the Phelps-Dodge copper properties. Dr. Douglas, himself a builder of big business, realized sure danger in the social reaction in which public opinion is the strongest reagent, and therefore he favored the wide-open door for ideas, on two counts—advancement of technical knowledge and education of public opinion. In urging "freedom from the stifling atmosphere of secrecy" he doubtless had in mind not only choked ambition and slowed-down technical advance, but the irritating effects of secrecy upon the public mind. Surely the best way to avoid public criticism is to let the full light of day shine on all the operations of business and industry.

In suggesting a larger interest by engineers in public issues, and in appealing to them as citizens it may be thought that I rest that appeal on sentiment. Quite the opposite is true; I urge their larger concern in civic matters because the present need is for less sentiment and more sense.

At bottom, the power issue is largely a technical matter. Yet I fear that the technical terms of engineering are too often introduced into the arguments for the purpose of camouflage—to conceal rather than to reveal meaning. Or they may be used merely for purposes of rhetoric. The point is that engineers can make large contributions to the current discussion of a subject too technical in many of its phases for other classes of citizens to understand properly. And I would urge a minimum use of technical terms; it is the engineer's duty to translate much that he knows on this subject into the language of "Main Street." Moreover, in using plain language he may indeed clarify his own thinking. Recently the editor of *Power* asserted that the basic unit in power engineering is not the British thermal unit but the dollar. This statement is technically correct, but it is more than that—it means measuring efficiency of service, not only in the boiler room but all along the line, by a standard everyone understands.

I am urging the engineer's participation in public consideration of the power question because that discussion, in its tone and purpose, needs his influence. Too often as I have listened to the speeches made on the subject of power I have been reminded of the persuasive but meaningless rhythm of tom-tom dances. Again and again the speakers reiterate the awful words "governmental interference" on one platform, and "power trusts" on the other, thereby working themselves and their audiences up to the desired pitch of enthusiasm or terror. The engineer, however, need not run for cover when the business advocate cries "government" or the political orator shouts "trusts." He may be influenced by silent facts but not by loud words.

What is needed then in the public discussion of the power issue is more facts and facts more clearly presented. Of course, back of the public discussion must be the quiet study of this issue, which presents both an economic and an engineering problem.

INSUFFICIENT DATA AVAILABLE

In its first report, the present Federal Power Commission thus states the need of more facts: "Any attempt to picture the present status of the power industry, much less to forecast its trend, discloses serious deficiencies in the information available for use." It is these blank spaces in the picture of economic conditions that should cause concern.

To meet the needs of both the industry and the public, the facts collected must cover the subject completely

and also carry the producer's label. To put it another way, the raw material for our facts can be derived only from the industry itself, but this material must be worked up for general consumption by some agency that has the public confidence. The trade association, as I have observed its trend, will play an increasingly important part in self-education. But in the field of education its province is first of all its own membership. Any attempts it may make to educate the general public are too likely to take on the color of propaganda, and even when the information issued is colorless, it will not be so looked upon by the industry's critics.

SURELY the best way to avoid public criticism is to let the full light of day shine on all the operations of business and industry.

IT is the Engineer's duty to translate much that he knows on this subject into the language of "Main Street."

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FACTS can be derived only from the industry itself, but this material must be worked up for general consumption by some agency that has the public confidence.

ENGINEERS AS COLLECTORS OF FACTS

As recently described by Director Feiker, of the Bureau of Foreign and Domestic Commerce, one of the practical objectives of the business association is "the setting up of such elements of fact-finding and statistical control as will enable business men intelligently to administer the policies of the groups and of their individual companies." To this description of purpose I would add that the cooperation of Government agencies is absolutely essential, for the trade association cannot be other than corporation controlled, and the public knows it.

The reason I am addressing engineers rather than statisticians is my conviction, based on experience, that to be useful, statistics need to be much more than the output of a battery of adding machines. The ideal collector of facts is the man who has spent years as a specialist in the works and in this way knows the reality behind the words and figures. Only the personal touch that comes from intimate familiarity with facts at their source can give life to statistics.

My experience in using government reports as sources of material for study is that the statistics issued for the central electric stations of Canada are superior to our own, especially in timeliness. The Canadian reports are annual and are published the second year after the figures are collected; our census is taken only every five years and the publication date is three years later. It is plain that with an industry as progressive in every department, and growing as rapidly as the light and power business, facts that have aged in the course of their collection and preparation for consumption are likely to be too stale for practical use.

Yet, whether the statistical report used in the course of an economic inquiry comes from Washington or from Ottawa, disappointing gaps are discovered. This can best be shown by examples, but my purpose in citing deficiencies is not to overlook the mass of detailed information made available in these authoritative reports; rather it is to suggest how the compilations may be made more useful.

To illustrate—one of the more common topics of public interest is the relation between the rates for household electric service charged by commercial and by municipal plants. If this comparison is made by determining the average revenues per kilowatt-hour received from each class of customers, the user of the U.S. Census tables for 1927 encounters a column headed "undistributed by class of service," which includes 10 per cent of the total number of customers of commercial companies and more than 20 per cent of the customers of municipal establishments. Moreover, there is another large item described as "other service," and these miscellaneous items, which the census authorities refer to as "disproportionately large," represent more than 5 per cent of the current sold and 9 per cent of the revenue received. Plainly, with two and a half million customers unclassified, no exact figures can be given for the average rate paid for residential service either to the private company or to the municipality.

On this subject, the Canadian Government report for 1929 yields even less of detailed information. Here the municipal stations, with 10 per cent more customers, generate only 40 per cent as much electric current as the commercial companies. The average revenue per kilowatt-hour is 0.55 cents for the commercial plant and 1 cent for the municipal plant. With the relatively much larger amount of purchased power sold by the Canadian municipal establishments, the comparison of average revenue is vitiated by this undifferentiated item of resold power, so that the economist again finds himself lacking facts.

POWER PLANTS IN QUEBEC AND ONTARIO

The capital invested in the electric business of Quebec and Ontario makes up over 80 per cent of Canada's total and is essentially the same in the two provinces. Measured by product, however, the electric business of Quebec is over a third larger than that of Ontario, and this with only a little more than half as many employees. But, on the other hand, the customers of the Ontario power establishments outnumber those of the Quebec plants by 47 per cent. Evidently the number of employees is essentially a function of the number of customers, rather than of output, and the obvious relationship disclosed by this comparison is that the retailing of electricity to domestic and rural customers costs more than its sale in large blocks to industry. These comparisons are interesting and in some degree enlightening, but the element that destroys the value of these statistical near-facts is again the presence of purchased power, imported from Quebec into Ontario for resale. This vitiates the comparisons of both unit revenue and unit costs.

These examples of putting government reports to

the test of use may serve to indicate the nature of the gaps in authoritative information available for the searcher after facts. More and better statistics would seem to be one unquestioned need disclosed by such inquiries.

Reference has been made to a certain time value that attaches to facts about the power industry. The rapid growth of the industry makes production statistics soon out of date, and what is even more notable, constant changes are taking place as a result of technical advance. The monthly reports on power production which have been made by the U.S. Geological Survey for more than a decade, have presented a record of phenomenal growth. By keeping this record current, the Government bureau has furnished a barometer of business of unique value.

FACTS that have aged in the course of their collection and preparation for consumption are likely to be too stale for practical use. Dating an egg doesn't keep it good.

I HAVE come to look upon the national engineering society as a much needed open forum where facts may be presented regardless of what they prove, and where opinions may be expressed irrespective of their bearing upon conservative corporation practice or static government policy.

VALUE OF FUEL-EFFICIENCY RECORDS

Nor is this all. The record furnished of the year-by-year increase in fuel efficiency at public utility plants has exerted a stimulating influence. I am not, of course, claiming that conservation of fuel to the amount of more than two hundred millions of tons, with a value of perhaps a billion of dollars, can be credited to the agency that has recorded and commented on this increase in efficiency. However, I believe that the wide publicity given each year to the fact has contributed to the industry's most successful drive for economy, and I know that in specific cases the Geological Survey has helped owners of small plants with the good advice to employ consulting engineers. Furthermore, this monthly collection and dissemination of output statistics can be cited as evidence of the possibility of fact-finding by a government agency without overlooking the value of timeliness.

Comparable records of other noteworthy engineering advances are unfortunately not available. In the matter of increasing plant efficiency, the recorded data are scattered and not complete enough for country-wide averages. The difference between the high marks and the average is of course great. In fuel efficiency, already referred to, the maximum both at the beginning of the period covered and at the present time has been about double that of the average efficiency for the whole country. In terms of coal consumed per kilowatt-hour, in 1919, the average was 3.2 lb. and the amount at the best plant 2.0 lb. For 1931 the corresponding figures are 1.5 lb. and 0.9 lb. As to other phases of the industry's progress, the best information available is to be found in the annual inventories of accomplishment published by the technical press.

GENERATION COST A SMALL PORTION OF COST TO CONSUMER

One field of economic study of the power industry that has a large present interest to the public is the correct allocation of operating costs between the generating plant and the transmission and distribution system. Too often the generating cost is popularly regarded as the principal cost and the expense of transporting the current to the consumer as simply an overhead.

The general fact is known that the value of the dollar expended in construction has been going up as regards the power plant but going down much more as regards the transmission system. The practical effect of these opposed trends in capital requirements is to favor the steam station located near its load as against the water power site necessarily at some distance from it. The advantage of the "short haul" for electricity is demonstrated in a somewhat spectacular way by the choice of a downtown location by the New York Edison Company for its latest and largest power station in New York City. The difference in necessary investment in real estate as between this site and one in the Bronx, large as that difference would be, is several times offset by the higher cost of the underground transmission circuits. Indeed, in terms of kilowatts, the cost of such transmission is from two to four times the real estate differential for each mile of distance from the generating plant to the load.

That the public, despite its keen interest in electric rates, which must logically be related to costs, does not appreciate the many factors entering into the problem, and much less is able to weigh these factors, is in a way an indictment of the officials, public and corporate, who have not assembled the information. However, the engineering fraternity should also recognize its share in the responsibility, inasmuch as far too little of the mass of essential facts has been collected. What are these facts—that is a question the engineer must help to answer.

Fact collecting, however, is not enough. In contending here that the engineer's contribution to the power problem must also include his aid in the analysis of the facts, I am not advancing a new thought. Just about two years ago at an engineering meeting in New York I heard the warning, "Better leave economics to the economists." But at some recent conventions I have heard speakers declare that economics needs more engineering, and again that engineering needs more economics. The honors, therefore, are even and the conclusion is plain; the engineers and the economists are called upon to join forces. If this discovery is one to be credited to these troublous times, again we are being shown that red ink is an effective catalyzer of ideas.

ENGINEERS USE FACTS AS FOUNDATION STONES

In this partnership of engineer and economist, it will be the engineer's part to furnish most of the facts. The engineer calls them "plain" facts, because they do not lend themselves to display as readily as rhetorical phrases. He uses facts, not as pieces on a chess board to be moved back and forth in a contest of wits, but rather as foundation stones to be assembled in orderly fashion to hold up the superstructure of conclusions.

Long-Range Planning of Public Works

Activities and Procedure of Federal Employment Stabilization Board Explained

By D. H. Sawyer

Member American Society of Civil Engineers

Director of the Federal Employment Stabilization Board, Washington, D.C.

OF ALL the means advocated today to forestall another depression, none is more popular than long-range planning of engineering, and particularly of public works. This idea has found sympathy in Congress, resulting in the establishment a year ago of the Federal Employment Stabilization Board to study data and coordinate governmental construction. In this paper, delivered before the Engineering-Economics and Finance Division on January 20, Colonel Sawyer reviews the accomplishments of his board during its brief existence and points to opportunities for future service.

NEVER before in the history of the country has the spotlight of public opinion and interest been focused upon the construction industry as closely as during the past two years. Physical improvements have become such a commonplace among us that their importance has not been fully realized, even by those who spend their lives in creating them.

For the past decade or longer, communities, and particularly those concerned with their administration, have been calling for better practices in the execution of facilities to supply public needs. Another voice that has been growing in strength is that of those who desire to keep taxes at a minimum. During the depression still another voice has been heard, that of those who believe the construction of public improvements can be made a potent factor in providing employment for idle labor.

These illustrations are sufficient to concentrate the attention of the civil engineers of the country upon the increased responsibility that has been placed on their shoulders. This call to public service, in my judgment, should meet a very ready response.

The engineer has been prone to restrict his talents to the technic of his profession and center his administrative and public spirited judgment on the designing and execution of the work in hand. A broader field of usefulness awaits him, one in which he can play a larger part in the analysis and presentation of orderly programs of public works in states, counties, and cities. Engineers, more than any other group, should contribute to the timing and financing of public improvements by these political divisions.

Let us hope that the genius of the engineer, which has devised enterprises having usefulness and permanence almost beyond the dreams of man, will be extended in its resourcefulness to the administration and financial guidance of our public bodies.

Years of effort on the part of a number of groups and individuals who sensed that there would be a striking benefit to the Federal Government in conceiving its work in advance, finally resulted about a year ago in legislation creating the Federal Employment Stabilization Board to carry out such a policy. The new organization is composed of the Secretaries of the Treasury, and of Commerce, Agriculture, and Labor. As created by Congress the board is empowered to engage in three distinct activities; advance planning of Federal construction; collection of statistics on business and construction; and rendering assistance to states, counties, and cities in connection with their construction programs.

The U.S. Government is a complex institution, whose departments and bureaus, brought into being at different times, have diverse interests circling the globe. A hundred or more units concern themselves with construction, maintenance, and repairs. The minutiae of administration and methods have not been greatly standardized and vary in each unit. This applies to the administration of the headquarters offices in Washington, to the field set-ups, the types of work undertaken, fiscal and accountancy systems, and many other phases reaching from congressional action to the final completion of an enterprise. To become conversant with the complexities of this problem has required an interesting pursuit of information.

I am glad to state that the officials in charge of these agencies, entirely aside from the mandate of the bill, have been cooperative in furnishing information and carrying forward the program in an orderly way. Briefly, I will describe the three phases of the board's work.

The act is very explicit in naming the agencies which will contribute to planning and in giving definitions of terms, together with the details of scheduling improvements. It definitely names a number of construction agencies, but the President, by executive order has broadened it to include all units. The term "construction" is inclusive of repairs and alterations.

Of practical interest to engineers are the clauses relating to the method of planning and reporting recommended projects, as follows:

> Sec. 8 (*b*) Each head of a department or independent establishment having jurisdiction over one or more construction agencies shall direct each such construction agency to prepare a six-year advance plan with estimates showing projects allotted to each year. Such estimates shall show separately the estimated cost of land, the estimated cost of new construction, and the estimated annual cost of operation and of repairs and alterations.
>
> (*c*) Each construction agency shall also prepare a program for prompt commencement and carrying out of an expanded program at any time. This program shall include organization plans. It shall also include the plans for the acquisition of sites and the preparation of advance detailed construction plans for not less than one year in advance, except where in the judgment of the board this would not be practicable. . . .
>
> (*e*) Each construction agency shall keep its six-year plan up to date by an annual revision of the plans and estimates for the unexpired years and by annually extending the plan and estimates for an additional year.

Since the cost of Federal construction activities runs into hundreds of millions of dollars each year, and the

projects are located in every state of the Union and in many foreign countries, the problem is that of forecasting needs six years in advance and of allocating the construction planned to definite fiscal years. Fortunately for the Government, however, the administrative officials and the staff of the construction agencies have been in business for many years and have a thorough understanding of their duties. In behalf of many of these agencies, let it be said they had previously been thinking in terms of the future and already had well-thought-out programs. The practice has been, and still continues, for departmental heads to submit requests for funds to the Bureau of the Budget, which requests are subsequently acted on by Congress. It is now provided by the legislation creating the Stabilization Board that these officials must predict their needs, not for one year, but for six.

It was apparent from the beginning that in dealing with such a large number of units it would be necessary to devise a blank form which would apply to the activities of the various agencies. I am glad to relate that such a form, as finally approved, has succeeded well in bringing in the essential facts of long-range planning.

Some time ago the construction units were called upon to submit advance plans of construction and maintenance and in a large measure these have been received. It became necessary in many instances to seek further information in order to make these plans as complete and understandable as possible. However, the routine and mechanics of reports have been very well observed. It is fair to say, I think, that a new and better system of presenting governmental projects has been devised. The legislation was wise and, with patience and tolerance, will become more efficient as the intricacies of the problem become better understood.

Two other forms have been found necessary: one which will inform the board from month to month as to the appropriations authorized by Congress, together with allotments made by the construction bureaus to definite projects; and a monthly form indicating the progress of construction from the stage when plans are being drawn up and sites acquired to the final completion of the enterprise.

The act imposes on the board the obligation "to advise the President from time to time of the trend of employment and business activity and of the existence or approach of periods of business depression and unemployment in the United States or in any substantial portion thereof...."

Sec. 4(*a*) In advising the President the board shall take into consideration the volume, based upon value, of contracts awarded for construction work in the United States, or in any substantial portion thereof, during any three-month period of three previous calendar years.

(*b*) The board may also take into consideration the index of employment prepared by the Department of Labor, and any other information concerning employment furnished the Department of Labor or by any other public or private agency, and any other facts which it may consider pertinent.

It will be seen that considerable latitude is granted the board in carrying forward the statistical branch of its work. Its policy is not to duplicate the efforts of governmental bureaus in gathering detailed figures, but on the contrary to give every encouragement to agencies of this character so that their own data may be as complete, reliable, and continuous as possible.

The stipulation that general business conditions are to be studied is interpreted to mean that we shall make use of those business barometers, both in this country and abroad, that have been subjected to analysis to establish their trustworthiness, and of those most widely used by economists.

It seems that our greatest opportunity lies in creating, month by month, a more complete picture of the construction industry in all its diversity than has been possible in the past. To that end we have divided this industry into five categories: (1) employment, (2) production or shipment of materials and equipment, (3) contracts awarded, (4) building permits, and (5) financing. These activities follow each other in sequence, the last being the furthest removed from the actual employment of men. As these estimates become more complete they should check one another, depending on the lag, which should be readily discoverable.

Valuable as all these categories are, we attach the greatest importance to the financing of construction. This we subdivide into three parts, private construction, undertakings of public utilities, and public works.

We are very active at this time in maintaining contacts with agencies able to gather detailed statistics, as well as in forming new ones in order to make our data in these five categories as comprehensive as possible. While no one can foresee with mathematical certainty what may occur in business, it should be possible in the case of construction to look ahead several weeks or months and predict volume of work with more certainty than is now possible.

The bill is not explicit in defining just what part the board may play in encouraging advance planning procedure by states, counties, cities, and other agencies. However, we are charged to cooperate with these groups; and in order to discover the best means of doing so we have written a large number of letters and established many contacts. Everywhere we have found a belief in the need of foreseeing improvement requirements several years in advance, but we have found also that very few, if any, are attacking the problem with the thoroughness contemplated by the bill.

It would seem that, if it becomes possible for the Federal Government to schedule its improvements six years ahead, no greater difficulty should be encountered elsewhere. If national officials can foresee their requirements, other qualified public officials should also be able to adopt this better practice.

The city of Washington will be used for a laboratory test. Although its fiscal system differs radically from that of other cities of the same size, its public improvement needs follow closely those of such cities.

Many individuals and groups are advocating this new system. Likewise there are many who complain against the present burden of taxation. It would seem that a better accord could be reached between these two schools of thought if year after year responsible officials considered public works, not in terms of immediate necessity, but rather in terms of a forecast of several years.

To those states, counties, cities, and others who are anxious to study and apply it, the board is very anxious to make available what seems to give assurance of being a better method of public administration.

Employment Stabilization Studied in Minnesota

State University Conducts Comprehensive Research Work for Permanent Relief

By W. N. Carey

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Fortunately St. Paul inaugurated a five-year public improvement program of considerable magnitude in 1928, and this, together with the private construction stimulated by it, is estimated to total $50,000,000. This work, however, is coming to an end and unemployment is increasing. In the following article, prepared from a paper presented before the Highway Division in session on January 21, 1932, Mr. Carey outlines the comprehensive scientific effort being made by the University of Minnesota to determine the causes of unemployment in the large cities of the state and to find methods of permanently stabilizing employment. The research organization, which was formed six years ago, has the resources of the university and nearly a half million dollars of outside funds available for its use.

It may be asked what interest or benefit the engineer can derive from an account of the work being done in the Twin Cities, in connection with the unemployment problem. Nearly every technical or semi-technical periodical published in the past six months has carried an article describing what has been done or will be done toward unemployment relief in this, that, or the other city, village, or hamlet. However, every citizen who has the welfare of his country at heart cannot help but be interested in this new type of attack on the tremendous forces causing unemployment—a type which, in scope and character, is absolutely unique nationally and even internationally.

This work in the Twin Cities is being carried on under the direction of an organization ponderously called the University of Minnesota Employment Stabilization Research Institute, and is being financed in part by the State of Minnesota and in part by an allotment of nearly half a million dollars from the Spellman, Carnegie, and Rockefeller foundations. It is likely that in no other place in the country is the local problem of the stabilization of employment being approached with such scientific thoroughness as in the Twin Cities. This work has been earnestly and quietly carried on since 1925. It is time the engineers of the country knew of its existence.

As a whole the problem of unemployment is staggering in size and complexity. So much has been said and printed about it and so many contradictory statements have been given out by the master minds of the nation that the common citizen is in a hopelessly bewildered state. Those of us who eat with a fair degree of regularity as a matter of course, are likely to receive with amazement the statement credited to Owen D. Young, that there are today twenty million people in the United States who do not know for certain where their meals for tomorrow are coming from, or whether they will eat at all tomorrow.

This number represents unemployed workers and those dependent on them. Organized charity, work relief programs, and similar measures probably will supply the bare necessities of life to from 5 to 15 per cent of the destitute and nearly destitute unemployed and their dependents. The bulk of the twenty million, however, are being fed by relatives and close friends, through loans on life insurance and exhaustion of small savings accounts. Employed workers and their dependents, to the approximate total of another twenty million, are straining their resources to keep the heads of their struggling relatives and friends above water. With this great number of our people out of the buying market except for the barest necessities, it is not to be wondered that this market is affected materially. Admitting that the estimates cited are subject to the same inaccuracy as other generalities, it is unquestionably true that vastly larger numbers than we like to admit are deeply involved in the existing depression.

Long-Term Municipal Planning

Like the rest of the nation, the Twin Cities are muddling through the present situation on a more or less hand-to-mouth basis. They have been more fortunate, it is true, than most of the larger cities in that they had just started public works of considerable magnitude, planned and financed on a long-term basis, when the black clouds of economic depression settled over the country. This fortunate condition applies to both cities, but more particularly to St. Paul. The story of how this city made a five-year public improvement program, financed it by a $15,000,000 bond issue in 1928, and started work on it in 1929, was described in my article in Civil Engineering for December 1931.

The public works activity started by this five-year program resulted in a marked stimulation of private construction. During the years 1929, 1930, and 1931, when most of the country was forced to spend as little as possible, St. Paul made an outlay of $50,000,000 for public and private improvements. Considering the city's population of under 400,000, the expenditure of this sum in such a short period had a decided effect on local employment conditions. However, St. Paul is now finishing its five-year program, and the number of unemployed is growing. It should be evident to all, as it is to residents of St. Paul, that long-term planning and financing of public works does flatten out the unemployment curve and further the public interest. This principle, true locally, should also be true nationally.

Local Sections of Society Afford Temporary Relief

St. Paul and Minneapolis, like other cities throughout the nation, have materially increased the funds of their community chests and organized charities for 1932. But most such funds are expended for the direct relief of

only the completely destitute; organized charity is not likely ever to make work for honest hands to do.

The engineers of St. Paul and Minneapolis, like those of other cities, have contributed their efforts, comparatively feeble though they are, toward immediate unemployment relief. They have progressed in the study of the problem as a whole to the point where they recognize that a solution will never be reached through the work of committees of engineers, bankers, or any other single professional group. The Minnesota State Committee, appointed by American Engineering Council, has labored diligently for many months but has been able to accomplish little in the way of tangible results. It has advocated work relief or "made-work" programs, and has lent its support to a joint state and Federal project for topographic mapping.

Some months ago, the Northwestern Section of the Society formed an unemployment committee. A direct report on about 80 per cent of the local membership shows but two out of work and none in need. All members of the Duluth Section are reported to be employed at present. These sections of the Society have sponsored and vigorously advocated a project for topographic mapping in Minnesota. They have explained to the governor in detail the public need of state topographic maps and the way in which, under the provisions of the Temple Act, the Federal Government will match state funds dollar for dollar for the proposed work. To date no state allotment has been made, but the governor has listened attentively and sympathetically to this plea. All engineering clubs in the state have been requested to unite with the civil engineering group in its attempt to obtain a state appropriation of $50,000 for mapping. Thus united, we hope to be successful in the near future.

The nation is today afflicted with a severe economic illness. Temporary relief measures are of course essential but the problem is much larger and calls for a proper investigation of the circumstances which led up to present conditions.

STABILIZATION RESEARCH INSTITUTE FORMED IN 1926

The work being carried on in the Twin Cities and Duluth by the University of Minnesota Employment Stabilization Research Institute is a serious, competent, and well financed effort toward the finding of a cure, or at least of a way to a cure, for some of our economic ills. In the foreword to a series of reports to be made as the work of the institute progresses, Lotus D. Coffman, President of the University of Minnesota, states the situation very clearly, as follows:

> In the sodden tracks of every economic depression, unemployment, with its tragic consequences, comes stalking along. No one knows how to cure it, yet everyone has a solution. Palliatives without number are proposed, yet nothing emerges in the way of constructive action that seems to alleviate the distressing conditions. Nothing can be done until we have a better understanding of the facts. The lack of information as to the causes as well as the effect of unemployment upon individuals and institutions leads to ill-founded proposals for relief that ofttimes make the cure more dangerous to the welfare of society than the disease itself.
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> To obtain the facts seems like a colossal undertaking, and yet without them we shall continue to wander aimlessly and helplessly along. The staggering social consequences of unemployment make it a problem that demands careful and dispassionate study. In view of the nature of its organization, and the vast and varied resources at its command, it seems that a university is the type of instituton that should be assigned the task of making this study.
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> The University of Minnesota has accepted this responsibility in so far as its resources will permit. A local controlled study of causes and an experiment in methods of re-training have been undertaken in the three largest cities in the state. The plans involve the use of the research facilities of several divisions of the university, including economics, business, sociology, psychology, education, engineering, and medicine. Members of the staffs in these several divisions have pooled their interests in a concerted attack upon the problem of unemployment in this region.

With the fearless and clear-thinking approach to the problem enunciated by President Coffman, and with the resources of the university, augmented at present by nearly half a million dollars, behind the work, there is reason to expect that sound and valuable conclusions based on cold facts will be reached. The three general objectives laid down for the work are given in Bulletin No. 1 of the Employment Stabilization Institute as follows:

> The first objective of the staff . . . is to ascertain how industrial changes are affecting the volume and character of employment in this region. In the second place, the data obtained in the survey will be analyzed with a view to revealing the types of vocational training and guidance that are needed under modern industrial conditions. The third major objective consists in attempting to determine what changes may be made in business organization and management that would help to stabilize the conditions of employment.

Over one hundred trained men and women are examining detailed records of unemployed workers; interviewing and testing thousands of them; and going into factories, workshops, and mines to get pertinent, first-hand information. Those engaged in this work are not professors of economics looking for proofs of ready-made theories, but are keen technicians seeking and finding facts out of which sound economic principles can be constructed. Although they have been engaged in this research for over six years, they have no more idea what the ultimate answer will be than we have. They appear to be approaching the difficulty in a way that assures ultimate success if such success is possible.

Of necessity, the study being undertaken in the Twin Cities is based on local conditions. However, a microscopic examination of economic problems, causes, and results in a suitable section of the nation should result in findings that will be generally applicable. To all those seriously interested in the stabilization of employment, I earnestly recommend a study of the invaluable work already accomplished and that now being carried out by the University of Minnesota Employment Stabilization Research Institute.

Economic conditions similar to those of the present but less severe have occurred before, but the depression appears to become worse with each recurrence. The present situation, which denies employment to six million workers and prevents more than ten million of their children from enjoying the rights and privileges guaranteed them by the Constitution of the United States, strikes at the very foundations of our government. Engineers should take this problem to heart more seriously than they are doing at present. By training and occupation they are fitted to play a vital part in the most important job now before the nation—that of diagnosing, prescribing for, and curing the country of this serious economic illness—unemployment.

New Jersey Approaches to the George Washington Bridge

By J. L. BAUER

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PROBABLY nowhere in the United States has there been concentrated in an area of equal size as large an amount of expensive highway construction as that within a ten-mile radius of the New Jersey end of the George Washington Bridge over the Hudson River. Of the $44,000,000 being spent within that circle, more than $9,000,000 is allocated to the work within one mile of the bridge head. A glance at the accompanying map indicates a maze of grade separations, overpasses, ramps, underpasses, and bridges over railroads and rivers, but a study of the highway net reveals provisions for a well ordered flow of vehicles in which no traffic lanes cross each other and all departures from the through route are made by turns to the right. The following article, prepared from a paper presented by Mr. Bauer on January 21, 1932, before the Highway Division at the Annual Meeting of the Society in New York, describes the comprehensive plans made by New Jersey to provide for traffic over the world's greatest suspension span.

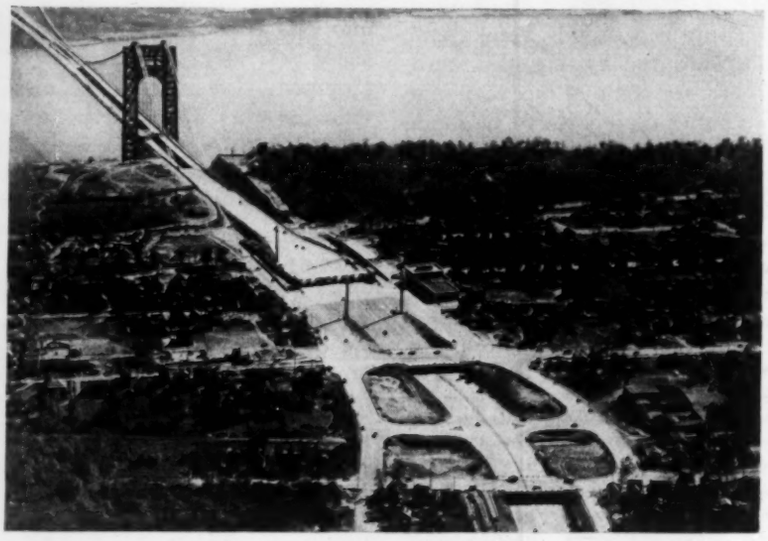
NEW Jersey's State Highway Commission is working under a legislative act of 1927, which sets up a system of some 1,842 miles of state highways. This mileage does not appear to be very great in proportion to that in some other states. New Jersey is unique, however, in that the county is a very strong road-building unit. County road mileage and also some municipal mileage must be added to the state system for purposes of comparison with most other states. On this basis New Jersey has some 7,000 miles, against 14,000 miles in New York, and 29,000 miles in Pennsylvania, where the state has recently taken over 20,000 miles of township roads.

The routes called for were described in the act in a general way and the State Highway Commission was instructed to lay them out between the points named in as short and direct a manner as practicable. Existing highways were to be made use of where possible, but the commission was also empowered to acquire rights-of-way for new roads. Under this legislative authority much work has been done by the State Highway Commission. More than two-thirds of the entire specified mileage has been completed to date and is in use.

Some of the most important highway construction carried on under the 1927 laws includes the plaza and connecting highways of the George Washington Bridge over the Hudson River at Fort Lee, N.J. Prior to the construction of the bridge, traffic through Fort Lee was chiefly north and south, to and from the Palisades Interstate Park and points in New York State. This traffic was very great in volume during the summer, the old north and south route frequently carrying 20,000 cars per day on Saturday or Sunday. But the old highway was narrow and this amount of traffic caused great congestion, especially through Fort Lee and points south. Also, for many years there has been a ferry line from a point just south of Fort Lee to 130th Street, New York City, the traffic from which ran for the most part through Fort Lee and thence to the north and west.

In designing the bridge plaza itself, consideration had therefore to be given not only to the traffic from the new bridge, but also to that moving north and south through Fort Lee, which it was thought would increase a great deal because of the bridge location. A plan was prepared for the bridge plaza proper and was approved in 1929 by a committee appointed for this purpose, consisting of O. H. Ammann, M. Am. Soc. C.E., Chief Engineer of the Port of New York Authority; R. P. McClave, Engineer for Bergen County; S. Wood McClave, M. Am. Soc. C.E., Engineer for the Borough of Fort Lee; and J. L. Bauer, M. Am. Soc. C.E., New Jersey State Highway Engineer.

In accordance with this plan, a "division line of jurisdiction" was set up at a distance of about 1,700 ft. from the bridge head, as representing the point where the jurisdiction of the Port of New York Authority would end and that of the State Highway Commission of New Jersey would begin. This line crosses the approach between the ticket booths and LeMoine Avenue, Fort Lee. The Port Authority procured all the necessary rights-of-way and paid all construction costs out to the "division line of jurisdiction." From this



ALL GRADE CROSSINGS ELIMINATED ON APPROACH HIGHWAYS
Fort Lee, N. J.; George Washington Bridge

line westward the Port Authority had already obtained some rights-of-way, which were turned over to the State of New Jersey. All the remaining rights-of-way and all construction costs west of the line of jurisdiction were paid for by the State Highway Commission of New Jersey.

LeMoine Avenue was at the time the main north and south highway through Fort Lee, the only other important north and south street being Hudson Terrace. There were no important east and west thoroughfares at the bridge head or within the area of the bridge plaza.

ROUTES MENTIONED IN THE ACT

The highway routes mentioned in the Act of 1927 as having to do with the bridge plaza are as follows: Route 4, which according to the act, will run from the bridge plaza to Cape May, the entire length of the state; Route 6, which is described as running from the bridge plaza to the Delaware River, that is, entirely across the state; and Route 1, described as running from Alpine to Bayonne, which is the whole length of the state along the Hudson River. There are several other short sections described in the act, which are connections to, and amplifications of, these three routes. Other routes are also mentioned, which are designed to connect with these main highways and furnish access to the bridge from all parts of the state.

The traffic going west from the bridge on Routes 4 and 6 mingles together for the first three-quarters of a mile from the bridge head, at which point Route 4 branches off to the north and thence to the west, running through Englewood, Teaneck, the upper end of Hackensack, and into Paterson. Route 6 goes to the south through Palisades Park, Ridgefield Park, Hasbrouck Heights, and thence to Clifton. Provision has been made for the north and south traffic which crosses near the bridge head by the construction of four new highway sections, which underpass or overpass the bridge traffic.

A full system of connections is provided between the east and west and the north and south highways so that motorists can proceed in any direction desired. This is accomplished, with no crossing of traffic lanes, by means of overpasses, underpasses, and ramps, all traffic turning to the right both to enter and to leave the plaza.

In general, it was considered advisable to lay out and construct the plaza for the full contemplated carrying capacity of the bridge, even though it was known that the bridge would not be opened or in use to its full capacity for some time. It was thought that the rights-of-way for the plaza could be obtained then at less cost than in the future. It was also considered that constructions such as bridges and viaducts should be built originally to their full width and not added to later. As a result, the entire construction is being carried out in full, as planned. This of course does not mean that it is final, as there is hardly a doubt but that future traffic will require other construction for its accommodation at and near the bridge.

EXTENT OF BRIDGE PLAZA

The bridge plaza proper extends out to about 6,000 ft. from the bridge head, whence the distance to Paterson on Route 4 is 11.5 miles, and that to Clifton on Route 6 is about the same. The total mileage of new roadway in the bridge plaza, including the beginning of Routes 4, 6, and 1, and the smaller connecting routes, as previously mentioned, is 31 miles. Within this mileage there are now completed or under construction 38 highway grade separations, 4 railroad crossing grade separations, 3 trolley railway separations, and 5 bridges over major streams. In addition, there are proposed and will be built as a part of the system, 8 highway grade separations, 5 railroad crossing grade separations, and 2 bridges over major streams. Also under construction or completed are 2 traffic circles.

Upon leaving the bridge the approach passes over Hudson Terrace and then under LeMoine Avenue,

FIG. 1. APPROACH HIGHWAY NET IN NEW JERSEY
A Maze of Grade Separations, Bridges, and Traffic Circles

Center Avenue, Linwood Avenue, and Fletcher Avenue, all in Fort Lee. Between LeMoine Avenue and Center Avenue it goes over the tracks of the Public Service Street Railway, which are in a covered crossing some 550 ft. in length. Ramp connections are made to and from 4 of the 5 streets which are crossed in Fort Lee. Somewhat west of Fletcher Avenue there are 3 highway crossings at one intersection, each at its own grade.

HIGHWAY PLAN AT TOLL BOOTHS
West End of the George Washington Bridge, Fort Lee, N.J.

The lower roadway is for ingress to and egress from Route 4 to Fort Lee proper, and leads to the south toward Jersey City. The central level is the eastbound or bridge-bound roadway of Route 4, which is here separated from the westbound roadway. The upper level at this intersection is the two-way viaduct of Route 6. Route 4, proceeding to the west, overpasses all highways for a distance of about 6 miles until Hackensack is reached. Route 6 overpasses and underpasses practically all highways as far as Little Ferry, a distance of about 4 miles. Both of these routes, as they continue across the state, will be provided with many similar overpasses and underpasses and also with traffic circles.

Within the bridge approach area there are two excellent examples of the "clover-leaf" construction, which is suitable only for the crossing of two highways. One highway is carried over the other, and ramp connections are built to carry traffic in all directions without any one lane of traffic crossing another. Most of the other overpass and underpass constructions are modifications of the clover-leaf idea. This type of intersection has been found very efficacious in providing for expeditious moving of traffic with comparative safety.

REINFORCED CONCRETE PAVEMENT USED

The roadways are made entirely of concrete, being built in lanes 10 ft. in width. The minimum over-all width of pavement is 20 ft., and the usual width is from 36 to 60 ft. The maximum width, 340 ft., is at the ticket booths of the bridge. The main highway from the bridge head to the separation of Routes 4 and 6 is from 80 to 100 ft. in width between curbs.

For the most part, the concrete is 10 in. in thickness, and carries two lines of reinforcement weighing about 160 lb. per 100 sq. ft. One part of the work is 8 in. thick with two lines of reinforcement, and another is 9 in. thick with one line of reinforcement. The concrete mixture of 1:1¾:3½ was applied fairly dry. Core borings 6 in. in diameter taken from these pavements 28 days after completion show average compression strengths of 5,000 lb. per sq. in. Nearly 20 miles of white concrete curbing was constructed in the work, a part being low curbing with a 1-in. curb face and a 3-in. upward slope in a 12-in. width, which type is constructed around islands and in the centers of roadways. The other type, 9 in. high with a face of 8 in., is laid along the main roadways and in the ramps. White concrete is used in order to give better visibility, especially at night.

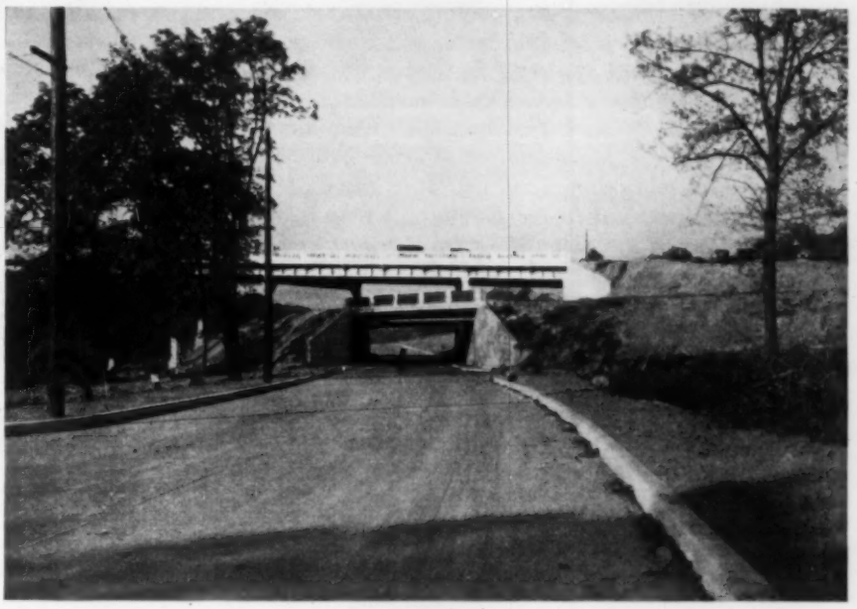
At the point in Fort Lee where the Public Service Street Railway runs underneath the bridge approach roads, borings disclosed that there was a muck mass some 20 ft. in depth. The plans which had been made for the Public Service tunnel called for three independent lines of footings, one under each abutment and one under the center pier, connected by concrete struts and supported on timber piling to be driven to rock below the muck. When the pile driving was started it was discovered that the muck was very soft and unstable, and it was feared that, although the piling was adequate to support the superimposed vertical load, it might be unable to resist the lateral thrust that would be caused by roadway embankments. It was therefore decided to remove the muck down to hard bottom and refill the space with an available rock fill.

When this work was started it was found impossible to accomplish it by the usual excavation methods because of the water-logged condition of the muck and the slope taken by it during excavation operations. A system of well points was then installed around the edge of the excavation and the excess water pumped from the subsoil. Only a few days of pumping sufficed to clear out the water so that the work could proceed. The excavation was then completed, the rock fill placed, and the construction of the street railway tunnel started at once. There has been no settlement of the construction at this place.

Where Route 6 crossed the Hackensack River Mead-

ows the muck of the meadows was removed by blasting. First the meadow crust was broken up by light charges of dynamite and the placing of the fill was then started. Ditches were blasted at the sides of the roadway and outside the bottom of the slope to facilitate the displacement of muck. When the filling was laid and the movement of the muck caused by its weight had temporarily ceased, holes were bored through the fill and charges of dynamite were placed in the muck under the fill. The explosion of the dynamite pushed the muck out toward the side ditches and caused the fill to settle in the place of the muck. On Route 4, at the Hackensack River, the muck was found to be from 4 to 12 ft. in depth, but there the soft material was excavated and the fill placed directly on a firm foundation.

On almost all the routes the slopes, berms, and islands are being, or will be, covered with top soil and they will be treated with fertilizer and seeded. In some cases the slopes will be planted with vines and shrubs to prevent erosion.



THREE-LEVEL HIGHWAY CROSSING AT VIADUCT
New Jersey Approach to the George Washington Bridge

COST WILL BE LARGE

The costs of the work of course have been considerable. The expense of right-of-way and construction of the bridge plaza proper, within one mile of the bridge head, is $9,320,000, of which sum the State Highway Commission will pay $5,300,000, and the Port of New York Authority, $4,020,000. The entire cost of all state highway construction, including that here mentioned and other sections, all lying within 10 miles of the bridge head, is estimated to be $40,000,000. This sum covers all work planned on the bridge approaches and on all other roads that have been and will be built under the present legislation within this 10-mile area, but it does not include the Holland Tunnel approaches in Jersey City, which lie just outside the 10-mile limit. Even if the bridge had not been built, a great deal of this road work would have been done. Just what part of the entire cost is chargeable to bridge traffic cannot be exactly estimated, but probably it should be about one-half.

ILLUMINATED SIGNS AND HIGHWAY LIGHTING PROVIDED

The matter of erecting direction signs at the bridge plaza and on the approach roadways has not been fully worked out. It is thought that traffic conditions as they develop will determine just what signs will suit the situation best at the points where traffic diverges. It is probable that illuminated signs will be required so as to secure clear visibility at night as well as in the daytime. Although all turns are to the right, experience with other traffic circles and clover-leaf intersections tends to show that the general public must be educated, at least in a measure, in the use of such layouts, for motorists are likely to make wrong turns at first.

Lighting of the highways is another problem that has not been settled. The policy of the State Highway Commission is to light large bridges, clover-leaf intersections, circles, depressed roadways, and viaducts. Ordinary full-width highways, even though built on embankments or through cuts, are not lighted. Manifestly, if such lighting were done in one place it would have to be done in another, and the state would be faced with a tremendous lighting bill. The main bridge plaza has been equipped with light standards, as have also some of the main structures outside the plaza. The general lighting of the routes is not being considered by the commission.

Some planting of trees and shrubs along the bridge plaza and the various routes is contemplated, but it is probable that the natural earth and rock side banks and slopes at the plaza will not be disturbed.

In closing I desire to pay tribute to the Port of New York Authority and its engineers. The George Washington Bridge was ready for traffic nearly a year in advance of the date first set for its opening, which fact shows the almost unprecedented speed of its construction. Furthermore, the engineers of the Port Authority have been most helpful in giving aid, in every way possible, to the New Jersey State Highway Commission.

When it was found that the bridge would be opened in November 1931, the State Highway Commission was faced with the problem of greatly accelerating all construction. The situation was nobly met by our engineers and inspectors, who worked day and night on the approaches. Our contractors also pushed the work along far beyond contract requirements in order to have the roadways ready on the date of the bridge opening. The result of all this splendid activity was that when the bridge was opened in the early part of November, enough of the work was completed for the traffic which has used the bridge since then. However, the highway work is not completed in its entirety, and at a number of points local roads are still being used. It is expected that by the summer of 1933 much additional roadway will be completed and open for use.

Progress in Sanitary Engineering

Research Advances the Practice of Water Purification and Sewage Treatment

SINCE March 1930, when the preceding report of the Sanitary Engineering Division's Committee on the Progress and Status of the Art of Sanitary Engineering appeared in PROCEEDINGS, *much progress has been achieved in research and practice, and important court decisions have been made regarding the use and treatment of water, sewage, and industrial and municipal wastes. These developments are outlined in the first article which follows, an abstract of the committee's latest report as briefed by Mr. Pearse, its chairman. The report was read before the Sanitary Engineering Division on January 21, 1932, at the Annual Meeting of the Society.*

In the second article of this symposium of papers presented before the Division at the Annual Meeting, Mr. Donaldson discusses the activated sludge process, with special reference to the causes of, and methods for alleviating, sludge bulking. The last article of the group is an abstract of the report made by the Division's Committee on Sludge Digestion, of which Mr. Greeley is chairman. Although nearly a hundred separate sludge digestion plants are now in operation in this country, numerous problems of design, construction, and operation have been only partially solved. The report deals with operation procedures, such as seeding, heating, and sludge digestion.

Present Status of the Art

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BY greatly accentuating the effects of human and industrial pollution, as well as natural causes in deteriorating the quality of water supplies at the source, the drought of 1930 stimulated activity in the improvement of the physical qualities of water supplies during 1931. The drought has also pointed to the need of vigorously prosecuting additional water supply projects for the service of great centers of population dependent on upland sources.

The constantly rising standard of quality for public water supplies is resulting in the construction of many softening plants, with great improvement both in the processes and in the engineering construction for their accomplishment. The removal of iron and manganese is also increasing, as well as recarbonization of the treated water. In addition, there is a growing demand for the removal of suspended matter and taste-producing elements from the waste waters of treatment plants before discharge into streams, and of remedial or control measures at water filter plants.

Also, the 1930 drought has brought to light the limitations of available methods of water purification when coping with heavy pollution. Dr. W. V. Veldee, of the U.S. Public Health Service, studied an epidemic of an intestinal disorder which started at Charleston, W.Va., and later extended to cities along the Kanawha and Ohio rivers. This disease was attributed by Dr. Veldee to the public water supplies, notwithstanding the fact that these supplies met all analytical and physical standards of purity, except in some cases, as regards taste and odor. While the symptoms of the disease suggested an organic infection, the evidence indicated the presence of toxic products of chemical decomposition as the cause. This experience calls attention rather sharply to the fact that we lack a reliable measure of the permissible limits of pollution with which available methods of water purification can cope.

In the preliminary treatment of water supplies, attempts to avoid dust in the handling of chemicals have resulted in the installation of numerous pneumatic conveying systems. Bulk storage of dry chemicals in bins is becoming the rule in large plants. Dry feeding of chemicals has in general superseded feeding in solution, except for iron salts.

There has been a more general application of prolonged mixing prior to sedimentation. Mechanical agitators of varied design are being introduced in place of the older baffled mixing chambers. Particularly in softening processes, continuous removal of sludge is becoming common for settling basins. Longer periods of sedimentation, extending over three hours or more, are also being considered, even for waters as clear as those of the Great Lakes. In some instances, ice has interfered with the operation of the settling basin mechanism in winter time, and in consequence, some plants have been built with these basins under a roof.

It has become standard practice to enclose the entire area of water filters within a building. Experimental work at Detroit, confirmed by operating results there, and also at Cleveland, indicates that proper bacterial results can be accomplished with a sand bed which is made completely clean at each washing, and that the difficulties which have been experienced all over the country with sand beds can be eliminated by keeping them clean. This may be done by securing a suitable expansion of the sand bed. Washing may be accomplished at rates ranging from 24 in. per min. in winter time, to 42 in. per min. in summer.

In the control of tastes and odors, further advances have been made. The use of activated carbon has been

found effective, either in powdered form, applied directly to the water, or in granular form in filters, when a unit is operated at rates as high as 6 or 7 times the normal. Pre-ammoniation is growing in importance, particularly with chlorination, as it prevents the occurrence of tastes due to chlorine, or to chlorophenol combinations, and provides a more effective disinfection.

RESEARCH IS SOLVING MANY PROBLEMS

Research in one form or another is being carried on in the laboratories of most of the larger water filtration plants of the United States. Concentration of research in testing stations is now confined to those at Detroit and Chicago. The former has been devoted chiefly to studying problems of settling, rates of filter wash, and other details of filter design, and out of this work has come a new conception of the behavior of the sand grains. At Cincinnati the active testing work of J. K. Hoskins and H. W. Streeter, M. Am. Soc. C.E., in the U.S. Public Health Service is largely completed, but statistical studies are being continued.

Much has also been accomplished in keeping certain industrial wastes, more particularly phenol wastes, out of rivers. The removal of phenol wastes, however, has uncovered the presence of other wastes that are troublesome in water supplies.

The experiments of John R. Baylis, Assoc. M. Am. Soc. C.E., show three major problems in handling Lake Michigan water:

1. To produce adequate filter runs when microscopic counts are fairly high, the most practical method is to add lime to the water and precipitate out from 80 to 90 per cent of the micro-organisms.
2. Objectionable chlorinous tastes and odors can be prevented by the use of ammonia. Super-chlorination followed by de-chlorination is effective except for tastes from oil wastes. Activated carbon removes all objectionable tastes.
3. Control of the passage of flocculated matter through the filter may be obtained by adequate sedimentation of the coagulated matter and washing of the filters at very low losses of head.

The use of electrically-driven centrifugal pumps for water supply is increasing. Steel-plate pipe and steel-cylinder reinforced concrete pipe are becoming more common. In the distribution system, elevated storage tanks having capacities as large as 2,000,000 gal. are being installed in many localities.

IMPORTANT LEGAL DECISIONS RENDERED

Three decisions of great importance to the water supply planner have been rendered by the U.S. Supreme Court in the last three years: Wisconsin et al. vs. Illinois et al. April 14, 1930; Connecticut vs. Massachusetts, February 24, 1931; and New Jersey vs. New York, May 4, 1931. These three decisions indicate very clearly the trend of the court and support the doctrine of reasonable use or equitable division of interstate waters as against a strict interpretation of the common law and riparian rule, which would prohibit all diversions.

In the case of Wisconsin vs. Illinois, the court refused to prevent the diversion of the sewage of the Sanitary District of Chicago from Lake Michigan and held that the municipalities had a right to take water for domestic use from the lake, and having converted it into sewage, to dispose of it where they so elected. Further, the court allowed, in addition to the sewage flow, an ultimate diversion of 1,500 sec-ft. in order not to interfere with navigation. In view of the strenuous efforts of the complainant states to stop all diversion of water from the lake and force the return of the sewage into the water supply, this decision appears important.

In the decision of New Jersey vs. New York, the court said:

> The Master adopted the principle of equitable division which clearly results from the decisions of the last quarter of a century. Where that principle is established there is not much left to discuss. The removal of water to a different watershed obviously must be allowed at times unless states are to be deprived of the most beneficial use on formal grounds. In fact, it has been allowed repeatedly and has been practiced by the states concerned.

The Delaware River situation (New Jersey vs. New York) is discussed in full by Thaddeus Merriman, M. Am. Soc. C.E., and the Connecticut vs. Massachusetts case by Frank E. Winsor, M. Am. Soc. C.E., in the *Proceedings of the New England Water Works Association*, Vol. 45, pages 199–311.

INTERSTATE STREAM CONSERVATION AGREEMENTS

The successful development since 1924 of de facto river boards is of interest. Under the original 1924 agreement and three subsequent supplements, the departments of health of Pennsylvania, Ohio, West Virginia, Kentucky, New York, Maryland, Illinois, Indiana, Tennessee, North Carolina, and Virginia, are signatories to the Ohio River Interstate Stream Conservation Agreement and the chief engineers of these health departments constitute the Ohio River Board of Engineers. The primary purpose of this agreement and the basic aim of the Board of Engineers is to protect water works having their sources of supply in an interstate stream in one state from harmful pollution arising in an upstream or adjacent state.

In 1929, the departments of health of states lying in the basin of the Great Lakes—that is, Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania, and New York—executed an almost identical agreement and the work on the Great Lakes is practically the same as on the Ohio River.

Other agreements have been made by the respective state departments of health; in 1922, between Pennsylvania and New Jersey prescribing a basis for treatment of sewage discharged into the Delaware River; in 1925, between Pennsylvania and New York on interstate stream conservation, exclusive of the Delaware River, which was covered by supplemental agreement in 1930; and between Pennsylvania and Maryland on interstate stream conservation.

SEWAGE TREATMENT IMPROVED

In the field of sewage treatment the progress made has been largely in the development of apparatus and arrangement of plant; in research leading to the digestion of sludge with the aid of heat, in shorter periods of time than heretofore; as well as in the dewatering of sludge. General practice is undergoing review, particularly as regards the large plants. Stress is being

placed on cleaner streams. In the handling of industrial waste, industry is increasingly cooperating. The principles of stream cleaning are becoming more clearly understood.

For the preliminary treatment of sewage, grit-chamber design has developed, particularly as regards the handling of solids. In the grit chamber proper various

SEWAGE SLUDGE STRIPPER AT WEST SIDE WORKS
Sanitary District of Chicago

methods of cleaning have been introduced, including the use of traveling flights or continuous drag-scrapers and mechanical classifiers. Grit washers for separating organic matter from the reclaimed grit are also receiving more attention. Where brewing residues are very noticeable, centrifuging of the grit is proposed, to be followed by incineration.

Grease removal is also receiving attention. In the Chicago Sanitary District skimming by hand is practiced in the preliminary settling tanks at the North Side Works and mechanical skimmers have been installed at the West Side Works. At Los Angeles and Pasadena, separation of grease or fatty matter from the sewage is sought by aeration of short duration—from one to five minutes. Problems arising from the presence of oils and volatile fluids in sewers and sewage treatment works are discussed in the 1931 Report of the Committee on Sewage Disposal of the American Public Health Association.

SEDIMENTATION AND CHEMICAL PRECIPITATION

The competition between various types of clarifier mechanisms of revolving and straight-line type is becoming more keen. Considerable operating and test data are being accumulated, which should prove of value in defining the relative merits of the different devices and styles of apparatus. The behavior of the solids coming directly from sewage may be different from that of activated sludge. Extensive tests have been conducted at Chicago and Milwaukee on final settling basins for activated sludge to determine the most efficient design and the allowable rates of flow. Observations indicate the necessity of avoiding eddy currents if the removal of a high percentage of suspended matter is sought.

Chemical precipitation of sewage has come to the front in a new guise. Recently the use of ferric chloride and lime with or without macerated paper was undertaken at Dearborn, Mich. It will be interesting to see if the experiences of from 1890 to 1910 with lime precipitation in the United States and in England are to be repeated, with subsequent abandonment of the use of lime and iron. The working of the proposed procedures will be watched with interest.

SLUDGE DIGESTION AND DRYING

In the field of sludge digestion the Imhoff tank is being studied more critically in the United States, particularly in the northern states. Separate sludge digestion is becoming more popular. Research, however, is particularly desired on the actual behavior of sludge digestion on a large scale. Controversy still rages in the separate digestion field between the proponents of floating covers and fixed covers, and the advocates of tanks with mechanism and those without. The explosion at Woonsocket has emphasized the need of care in both design and operation. Any hazards of gas poisoning in manholes, operating galleries, or pockets should be avoided by suitable design to protect the workmen.

As to sludge drying on prepared sludge beds, glass covered beds are becoming more common in the smaller plants, although the principles of design are apparently not clearly understood by all makers. There is still a tendency to adhere too much to the methods of greenhouse manufacture, rather than to the needs of sludge drying. There still appears to be a divergence of opinion as to the general value of covered drying beds.

MECHANICAL HANDLING DEVICES

As regards outdoor beds, the most radical departure from common practice is in the sludge beds at the West Side Works of the Chicago Sanitary District. In these, the unit beds are about 80 ft. wide and from 600 to 1,200 ft. long, built in pairs and served by a standard-gage railroad track running between each pair. The beds are cleaned by special machines running on the dividing walls. These strip the sludge from the beds. One machine will handle upward of 1,500 cu. yd. in 8 hours. Operating tests indicate that the stripping machine apparently removes less sand than hand cleaning.

Sludge handling on a large scale, as at Chicago, seems materially simplified by the new air-drying bed and sludge-stripping machine loading into standard 30-cu. yd. dump cars. These may be run to the dump with an oil-fired locomotive. However, considering the sludge problem in a broad way, the elimination of digestion and sludge drying on prepared beds appears attractive. This procedure is being studied by the Chicago Sanitary District and others. It is proposed first to dewater the fresh sludge by a centrifuge or vacuum filter and then incinerate. The availability of ferric chloride as a conditioner is helpful, although other means of conditioning and of aiding filtration are being tried. Baltimore, Chicago, Columbus, and Los Angeles are studying the behavior of vacuum filters on various sludges.

At the present time, the trickling filter and the activated sludge process are the most commonly used for complete treatment. The development of digestion of the mixed fresh and excess activated sludge solids has

increased the interest in activated sludge in a broader way, particularly for smaller installations.

In the activated sludge process the importance of preliminary treatment is being recognized. In many installations, settling tanks are being used, with periods ranging anywhere from 30 to 60 min. on the average daily flow for a year. In the smaller plants in the United States there is a growing use of mechanical devices for aeration and agitation of the mixed liquor. In the large plants, air blowing is still preferred, with a spiral flow.

Other oxidizing devices have been tried in an experimental way, such as the nidus rack, colloidors, contact aerators and bacterial wheels, but the practical value of such devices is still open to question, as is also the degree of treatment that can be effectively accomplished by them.

MUCH RESEARCH ON SLUDGE HANDLING

In the field of pure research the New Jersey Agricultural Experiment Station, where Dr. Rudolfs and his staff operate, is outstanding. In large-scale applied research, the Sanitary District of Chicago, the Milwaukee Sewerage Commission, and the Baltimore Treatment Works are prominent. As regards stream pollution investigation, the U.S. Public Health Service has brought forward valuable material. Many operators and laboratory workers at different plants are carrying on special work of one kind or another. For those who are interested, the following brief outline of experiments currently under way may be noted, although it is probably incomplete:

The Sanitary District of Chicago is working with separate digestion, particularly of mixed fresh and activated sludge; on methods of sludge handling by centrifuge, vacuum filters, and by combustion; and on aeration, double activation, settling, and sludge friction.

At Baltimore and Columbus the use of vacuum filters for handling digested sludge is being studied.

Milwaukee is experimenting with vacuum filters and incineration for the disposal of activated sludge; and with the centrifuge and incinerators for the disposal of screenings.

The Los Angeles County Sanitation Districts are studying the activated sludge process and the digestion of sludge by stages.

The City of Los Angeles is experimenting with the activated sludge process to reclaim water from sewage; and with grease skimming.

In the field of research the work of the following agencies should be noted: the New Jersey Agricultural Experiment Station, the Illinois State Water Survey, Iowa State University, the Massachusetts State Board of Health, the Michigan Agricultural Experiment Station, the U.S. Public Health Service, the Harvard Engineering School, and the University of Illinois. The greatest interest seems still directed toward the sludge handling problem.

GARBAGE AND REFUSE DISPOSAL

Bids were recently taken by the District of Columbia for rubbish incinerators on detailed contract plans prepared by the engineers of the district. Thus all bids received were on a directly comparable basis. Such a development is encouraging, as the value of the engineer in the field of garbage and refuse disposal has been greatly hampered by the all too prevalent method of calling in an engineer to try to determine what equipment to accept, after bids have been taken from a number of manufacturers, with resultant confusion through lack of uniformity in the character of the work offered.

Of interest is the decree of the Supreme Court of the United States (May 18, 1931) in the case of the State of New Jersey vs. the City of New York, whereby it was held that the State of New Jersey is entitled to an injunction restraining New York City from continuing its practice of dumping garbage into the ocean or waters of the United States off the coast of New Jersey and from otherwise polluting New Jersey's waters and beaches.

The case was referred back to the Master for findings of fact as to what was a reasonable time for the building of incinerators. The Master submitted his report on reference to the October 1931 term of the Supreme Court. He found that New York City should provide a total average capacity of 3,000 tons per day in four incinerators, each with a rated capacity of 750 tons per day. He then concluded "that the additional incinerators which the defendant, the City of New York, had planned to construct in the Boroughs of Manhattan and the Bronx, with a rated capacity of 750 tons each per day, should be ready for operation on or before June 1, 1933, and that until June 1, 1933, is a reasonable time to allow the defendant."

Use of Activated Sludge Process Increasing

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IT is known that the activated sludge process is capable of dependably removing from sewage over 90 per cent of the suspended matter; over 90 per cent of the organic matter as represented by the biochemical oxygen demand; over 90 per cent of the ordinary saprophytic bacteria; and from 95 to 98 per cent of the bacteria that are associated with disease. When this type of treatment is supplemented by chlorination, the removal of objectionable bacteria can be made practically complete and the organic matter further reduced. Individual plants show greater reductions than indicated above as average good performance.

Effluents of the more important activated sludge plants in this country contain, on an average, from 15 to 20 p.p.m. (parts per million) of suspended matter, and have a five-day oxygen demand of from 10 to 15 p.p.m. Such an effluent, if well nitrified and aerated, is not likely to putrefy for several days, even if undiluted.

The results obtainable by the use of the activated sludge process are in all respects as good as, or better than, those obtainable by the use of trickling filters, and the effluent is physically more attractive. Moreover, the activated sludge process has the advantages of very much smaller area required; freedom from the fly nuisance, which is serious in areas closely adjacent to trickling filters; and avoidance of odors, which are at times objectionable when sewage is sprayed into the air.

For large projects, the status of the activated sludge process is shown by the construction of New York City's Wards Island plant to serve a population of over 1,200,000; by its adoption for the Easterly Sewerage District of Cleveland, Ohio, to serve one of 770,000; for the Stahnsdorf plant in the suburbs of Berlin, for one of 600,000; for the Mogden works of Middlesex County, England, to serve one of 700,000; and by its recommendation for the Hackensack Valley District plants in New Jersey to serve a population of 700,000. The process has been adopted also for a large number of smaller projects and for extensions to important plants in America, Europe, and the Orient.

For small projects, the activated sludge process is not regarded with as much favor as it was a few years ago. The principal difficulties arise from variations in both the volume and the strength of the sewage, and from lack of sufficiently skilled control. Among the problems encountered is serious deterioration of the quality of the final effluent, due to bulking of the sludge or other causes.

PLANT PERFORMANCE SUMMARIZED

Performances by activated sludge plants vary, and to facilitate discussion attention is called to a number of factors bearing on design and operation, as follows:

1. For large projects this process is assuming a more dominant position where it is important to provide so-called complete treatment. It is readily feasible to supplement this method by chlorination or filtration, or both if necessary.

2. For small plants this process has a less favorable status than a few years ago, due to fluctuations in plant loadings and difficulties in securing adequate technical control.

3. There are so many interrelated factors, involving the strength and flow of sewage, arrangement of plant, and method of operation, that it is unsafe to use basic data from one plant for adoption elsewhere without due appreciation of the various elements to be anticipated at a new plant, as shown by experience at other installations. This fairly new process has not become standardized in a rational way as rapid sand filters and other water purification processes have been as a result of the experience of the past thirty years.

4. Plant loadings, particularly as affecting the detention period in aeration tanks and the quantity of air per gallon, are obviously influenced by the strength of the sewage, which may average in volume from 75 to 225 gal. per capita daily; by the degree of preliminary treatment; by the relation between mean and maximum peak flows and strengths of sewage; and by the character and amount of industrial or other non-domestic wastes reaching the plant.

5. Suspended solids in aerating tanks range from 0.10 to 0.70 per cent by weight, perhaps 0.20 to 0.25 being representative of American practice, with the lower figures prevailing in Europe. The reporting of solids by settled volume alone is an inaccurate method, on account of the bulking factor.

6. There are wide variations in detention periods in aeration tanks, in air used per gallon, and in horsepower per million gallons. It would clarify data to express these elements on a per capita basis or in terms of a stated number of units of oxygen demand reaching the aeration tanks.

7. Short-circuiting is a factor of considerable importance in some of the smaller aeration tanks of the spiral flow type, and is of special importance with mechanical types depending upon continuous circulation of the entire tank contents.

8. De-oxygenation needs to be guarded against.

9. Re-aeration has its place for some conditions and is coming somewhat into vogue again.

10. Sludge bulking is not much of a factor at large plants dealing with dilute or well settled sewage but it is a factor at other plants. Its causes and remedies need elucidation, and a discussion of the subject is given here.

11. Sludge disposal by the use of heated digestion tanks and drying beds is thoroughly practicable, especially if the excess sludge from the final tanks is returned to the inlet of the preliminary tanks. Vacuum filters to produce a filter cake of from 20 to 30 per cent solid content are also practicable. The drying of filter cake to make a fertilizer is not now a commercial success on account of market conditions, and for several important projects attention is being given to incineration of the filter cake.

CAUSE OF SLUDGE BULKING

One of the chief difficulties encountered in the operation of many activated sludge plants is the bulking of sludge, which is largely responsible for the failure to maintain consistently, day by day, low quantities of suspended solids in the clarifier effluent. Sludge bulking may be defined as that condition of the sludge in which the settleable solids by volume are abnormally high compared with the weight of the suspended solids. In other words, the total weight of suspended solids in the system may be unchanged, but the solids exist in such a condition that they will not subside in a normal way.

In spite of the frequency of the occurrence of bulking there still exists a lack of agreement as to its underlying causes. The most plausible explanation is that sludge becomes permeated with excessive growths of filamentous bacteria, of which Sphaerotilus is the commoner and dominant type. The presence of this filamentous organism in considerable numbers gives to the sludge its fluffy, non-settling, and non-compacting qualities. It seems reasonable to believe that the development of these undesirable organisms occurs as a result of certain interrelated plant factors such as peak loads of organic units, limitations on the length of the aeration period, and the occurrence of short-circuiting through the aeration tanks. Within broad limits, the air supply seems to have little bearing on bulking. Sludge bulking may be said to be related to a measurable

degree to the "leakage" of dissolved organic matter through the aerating tanks into the clarifiers so as to afford sufficient food for the growth of Sphaerotilus or similar filamentous organisms.

At times there are, no doubt, purely physical conditions, such as wind action, high velocities, and rapid temperature changes, that interfere with normal subsidence of suspended matter in clarifiers, but the main points presented for discussion are the importance of microscopic growths of filamentous character as an immediate cause of bulking, and the fact that this causative element is seemingly a result of conditions which favor food supply for such growths, which we may refer to as the "weeds of activated sludge."

PREVENTION OF BULKING

It has been found feasible at the Tenafly plant to correct sludge bulking by the occasional use of lime in controlled doses for a limited period. The practice has been to add lime when needed at the inlet to the aerating tank, in quantities sufficient to maintain in the effluent of the tank a reaction of pH from 8.6 to 8.8, and to continue this for at least four hours. Lime application in this alkaline range seems to lessen the fluffy condition of the sludge by discouraging the undesired growths.

If the view here advanced is sound, that bulking is frequently, if not generally, related to "leakage" of organic matter through the aerators in quantities sufficient to provide a food supply for objectionable filamentous organisms, then the remedy obviously lies in adjustment of interrelated plant factors such as peak loads, aeration period, solids, supply of return sludge, and short-circuiting.

It is sometimes possible to flatten out a sharp peak loading by changing the operation of booster stations tributary to the sewer system, or by storing the peak load and returning it to the plant during off hours. The installation of baffles in the aeration tanks may correct short-circuiting. Another expedient is the use of re-aeration to complete the absorption and oxidation of dissolved organic matter not sufficiently accomplished in aeration tanks during peak loading. A reduction or thinning of the solids maintained in the aeration tank has been found a helpful expedient in connection with bulking troubles.

The behavior of the secondary clarifiers has been frequently blamed for failure to obtain low solids in the effluent. There is no doubt that good design of clarifiers as to proportions, kind, and speed of cleaning mechanisms, and inlet and outlet arrangements, is a matter for careful consideration; but more frequently the failure to get satisfactory subsidence is due to faulty treatment ahead of the clarifiers rather than to the clarifiers themselves. This is another way of saying that if good activation is maintained at all times the results are apt to be satisfactory, even with poorly designed clarifiers. Conversely, if the sludge in the aeration tank is in poor condition, the best of clarifiers will not prevent bulking or loss of solids over the clarifier weirs.

Committee on Sludge Digestion Reports

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WORK of the Committee on Sludge Digestion was divided into ten sections and a number of appendixes as follows: (1) general description of sludge digestion; (2) sewage characteristics; (3) types of sludge digestion tanks; (4) environmental factors; (5) quantity and capacity computations; (6) gas production and utilization; (7) sludge disposal; (8) operating routine of sludge digestion; (9) cost data; and (10) bibliography, glossary, and appendixes.

As sludge digestion depends in a large measure upon the characteristics of the sewage from which the sludge results, the committee made an effort to collect information on this topic. Through the associate members and others having to do with sewage works operation, replies to a questionnaire were received from 29 cities, representing a total tributary population of 4,767,000 people with average daily sewage flow ranging from 48 to 306 gal. per capita per 24 hours. Fifteen of these

TABLE I. QUANTITY OF TOTAL AND VOLATILE SUSPENDED MATTER IN POUNDS PER CAPITA OF POPULATION

City	Suspended Solids in Lb. per Cap. per 24 Hours		Per Cent Volatile
Combined Sewers:	Total	Volatile	
Decatur	0.510	...	..
Akron	0.491	0.371	75
Indianapolis	0.373	...	..
Milwaukee	0.331	0.220	66
Philadelphia	0.295	0.194	66
Syracuse	0.258	...	..
Grand Rapids	0.234	0.173	74
Rochester (Irondequoit)	0.199	0.139	70
Worcester	0.193	0.118	61
Columbus	0.178	0.141	79
Springfield	0.174	0.108	62
Flint	0.141	0.105	74
Fitchburg	0.068	0.043	63
Total	3.445	1.612	690
Average	0.265	0.161	69

City	Suspended Solids in Lb. per Cap. per 24 Hours		Per Cent Volatile
Separate Sewers:	Total	Volatile	
Canton	0.233	...	..
Dallas	0.208	0.157	75
Elyria	0.186	0.123	66
High Point	0.181	...	..
Pasadena	0.179	0.152	85
Madison	0.169	0.131	77
Rochester (Brighton)	0.163	0.118	72
Dayton	0.155	0.129	83
Alliance	0.140	0.100	71
Marion	0.139	0.105	76
Lincoln	0.110	...	..
Brockton	0.104	0.084	81
Delaware	0.094	0.074	79
Total	2.061	1.173	765
Average	0.158	0.117	76.5

cities had combined, and 14 had separate, sewer systems. A summary of the analyses relating to suspended solids and to the composition of digested sludge is shown in Tables I and II.

For the cities there tabulated the total suspended matter ranged from 0.068 to 0.510 and averaged 0.265

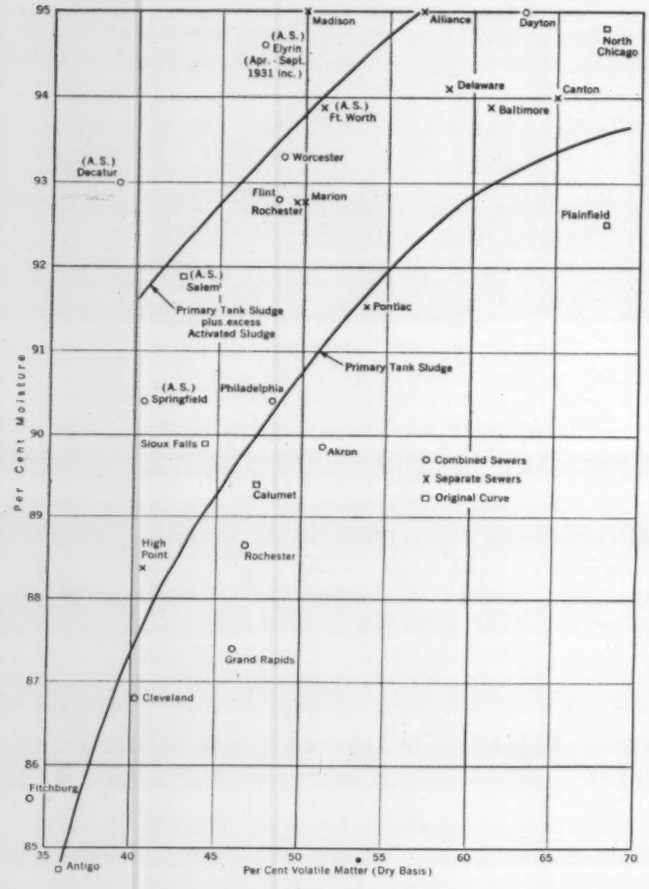

FIG. 1. RELATION BETWEEN MOISTURE CONTENT AND VOLATILE MATTER IN SLUDGE

lb. per capita per 24 hours. The volatile matter in the total suspended solids also varied, ranging from 85 to 61 per cent. The volatile matter in the suspended solids was 69 per cent for 10 cities with combined sewers, and 76.5 per cent for 10 cities with separate sewers.

On account of the great variety in the quantity and characteristics of sewage solids and their different behavior in digestion tanks, the committee wishes to make clear that broad statements cannot be made which are generally applicable. General principles should be applied in the light of knowledge of the sewage characteristics.

TYPES OF SLUDGE DIGESTION TANKS

During the past 20 to 30 years, and particularly during the last five years, sludge digestion tanks have been evolved from structures that were formerly little more than lagoons with sides of earth or masonry to tanks in which the contents can be heated, the gases of decomposition collected and burned, and the sludge mixed or agitated by means of pumps or other mechanical equipment. Typical installations of various types of sludge digestion tanks are described in the report.

The four major environmental factors which affect sludge digestion are: temperature; pressure; reaction and age; industrial sewage.

The committee summarizes the effect of temperature on sludge digestion as follows:

1. Up to 125 deg. fahr., or somewhat more, the time of digestion is decreased as the temperature increases.
2. There are not enough operating data from large size plants to justify a final conclusion as to the best and most economical temperature. Present information indicates that temperatures above 80 deg. fahr. and approaching 100 deg. fahr. are desirable for digestion. The general over-all economy of any particular digestion temperature should be a matter of local decision. The saving in cost and improvement of operating results with temperatures in excess of 100 deg. have not been established.
3. The duration of low winter temperatures will affect the relative costs of operation at different temperatures of digestion.

The effect of pressure on sludge digestion appears to be of minor importance.

TABLE II. COMPOSITION OF DIGESTED SLUDGE

CITY	SPECIFIC GRAVITY	PER CENT MOISTURE	pH VALUE	VOLATILE MATTER, %	ETHER SOLUBLE MATTER, %
COMBINED SEWERS:					
Akron	1.08	89.9	6.5	51.1	10.6
Cleveland	1.05	86.8	7.1	40.3	8.3
Dayton	1.00	95.0	6.8	63.0	14.0
Decatur	..	93.0	7.0	38.0	3.5
Fitchburg	1.05	85.6	7.1	34.4	..
Flint	..	92.8	6.6	48.3	10.1
Grand Rapids	..	85.6	7.6	46.4	..
Philadelphia	1.03	90.4	...	48.2	17.7
Rochester (Irondequoit)	..	98.7	6.6	46.9	8.3
Springfield	..	90.4	7.6	40.7	..
Worcester	1.03	93.3	6.8	48.8	..
Total	6.24	1001.5	69.7	506.1	72.5
Average	1.04	91.0	7.0	46.0	10.3
SEPARATE SEWERS:					
Alliance	1.02	95.0	7.4	57.0	..
Baltimore	..	93.9	6.7	61.2	..
Canton	1.03	94.0	6.7	65.0	..
Dallas	..	95.0	6.9	..	..
Delaware	1.03	94.1	...	57.8	..
Elyria	1.04	94.6	7.2	46.5	..
Fort Worth	..	93.9	7.1	51.2	..
High Point	..	88.4	7.8	40.5	6.3
Lincoln	..	89.2	...	..	..
Madison	1.02	95.0	7.4	50.0	10.0
Marion	1.02	92.8	8.1	50.0	8.0
Pontiac	..	91.6	7.0	53.9	..
Rochester (Brighton)	..	92.8	6.6	49.6	11.6
Total	7.21	1210.3	78.9	647.7	35.9
Average	1.03	93.1	7.2	54.0	9.0

Reaction is of major importance in sludge digestion. The effect of reaction and age on sludge digestion is summarized by the committee as follows:

1. Without a sufficient quantity of seeding material, acid reaction sludge occurs, resulting in delayed digestion.
2. Settled solids from sewage which has been held for many hours or days, in sewers or plain settling tanks, give an acid reaction.
3. Solids high in volatile matter from separate sewerage systems tend to produce greater acidity than solids from combined systems.
4. Liming is not recommended for normal operation, but may be of benefit for acceleration of digestion of acid sludge.

5. The seeding value of ripe sludge is independent of its moisture content within normal limits, but is somewhat dependent on its age.

6. Completion of digestion may be determined by physical and chemical characteristics of the sludge.

7. The nature of the initial solids and the degree of digestion measured by the loss of volatile matter are apparently more important than the depth or type of the tank.

Figure 1 was prepared by the Subcommittee on Reaction and Age in Sludge Digestion to indicate the relation between the moisture content and the volatile matter of digested sludge. The committee has summarized in the report the general characteristics of industrial wastes as they affect sludge digestion.

QUANTITY AND CAPACITY COMPUTATIONS

Formulas are derived in the report for the computation of sludge digestion and storage capacities for three different conditions of operation. Symbols used in the formulas are as follows:

M = million gallons of sewage daily
N = population tributary
S = dry solids, parts per million of sewage added to sludge chamber daily
SS = sludge supernatant
A = $8.3 \times S \times M$ = dry solids added, pounds daily
R = ratio of volatile solids added daily to volatile solids in tank
D = minimum period of digestion, in days
D_0 = complete digestion, in days
D_1 = duration between periodic sludge drawings, in days
D_2 = additional period beyond D_1 when no digestion occurs (uncontrolled Imhoff tanks in cold weather)
V = per cent volatile matter in solids
VA = volatile solids, dry basis added daily, in pounds
P = per cent volatile matter digested
PVA = amount of volatile solids added and digested daily, in pounds
$P'VA$ = ditto for complete digestion; $P' = \pm 0.75$
W_0 = water content of entering sludge = ±95 per cent
W_2 = water content of withdrawn sludge = ± 90 per cent
$W_1 = \frac{W_0 + W_2}{2}$ = mean water content of sludge in tank = ±92.5 per cent
C = theoretical capacity of sludge chamber, in cu. ft.
K = ratio of liquid sludge added daily to sludge in tank

1. CONTINUOUS OPERATION AND DAILY WITHDRAWAL

For this condition, it is assumed that a given weight of solids is added daily and that an equal weight disappears daily, by digestion and withdrawal, indicated thus:

$$C_1 \text{ (cu. ft.)} = \frac{AD - \frac{PVAD}{2}}{62.5\,(1 - W_1)} = \frac{0.008\,(2 - PV)AD}{1 - W_1} \quad \ldots [1]$$

2. COMPLETE DIGESTION AND LARGER STORAGE

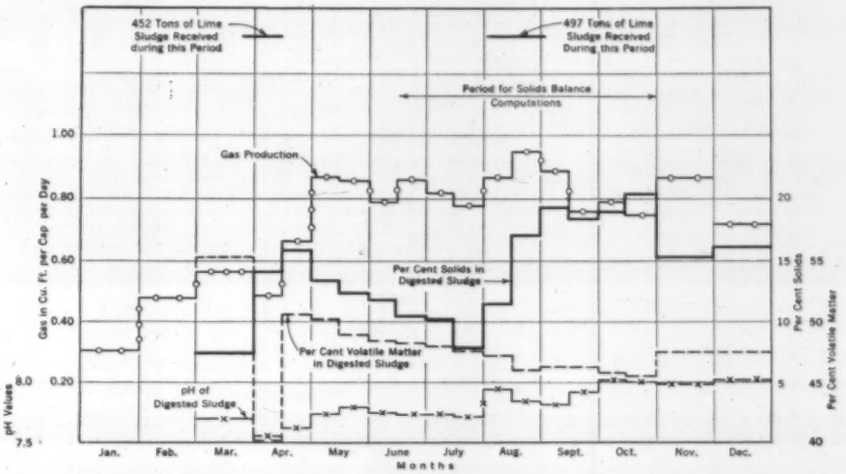

FIG. 2. DIGESTION TANK DATA, GRAND RAPIDS (MICH.) PLANT

When it becomes necessary to store sludge after the period required for digestion, greater capacity is needed than that provided for continuous operation and daily withdrawal, the total amounting to:

$$C_2 \text{ (cu. ft.)} = AD_0 - \frac{P'VAD_0}{2} + (D_1 - D_0)\,(1 - P'VA) = A\left[\frac{D_1\,(1 - P'V) + D_0\frac{P'V}{2}}{62.5\,(1 - W_1)}\right] \quad \ldots [2]$$

3. UNCONTROLLED DIGESTION AND LONG STORAGE THROUGH COLD WEATHER

In the case of uncontrolled digestion (Imhoff tanks without heat in a cold climate) it becomes necessary to store sludge during cold weather when digestion has practically ceased, and the capacity of the sludge compartment in cubic feet amounts to:

$$C_3 = \frac{0.75A}{2(62.5)}\left[\frac{(2 - 2P'V)\,D_1 + P'VD_0}{1 - W_1} + \frac{2D_2}{1 - W_0}\right] = A\,(0.006)\left[\frac{(2 - 2P'V)D_1 + P'VD_0}{1 - W_1} + \frac{2D_2}{1 - W_0}\right] \quad \ldots [3]$$

As the moisture content is an important item in determining the capacity of sludge digestion tanks, some information for separate digestion tanks is summarized in Table III. These figures indicate that, in many cases, the tanks were not full of sludge.

GAS COLLECTED AND UTILIZED

Sludge gas is being successfully used in the following ways: (1) heating sludge tanks, (2) heating buildings, (3) lighting, (4) operating gas engines, and (5)

disposal to gas companies. By far the greater part of the sludge gas in the United States is used to heat sludge tanks. Sufficient gas is often available to heat the sludge during the winter months up to a temperature where digestion is rapid, but the heat balance will depend upon many local factors and, in particular, the moisture content of the sludge. Various types of gas collection hoods, flame traps, and other appurtenances are illustrated in the report.

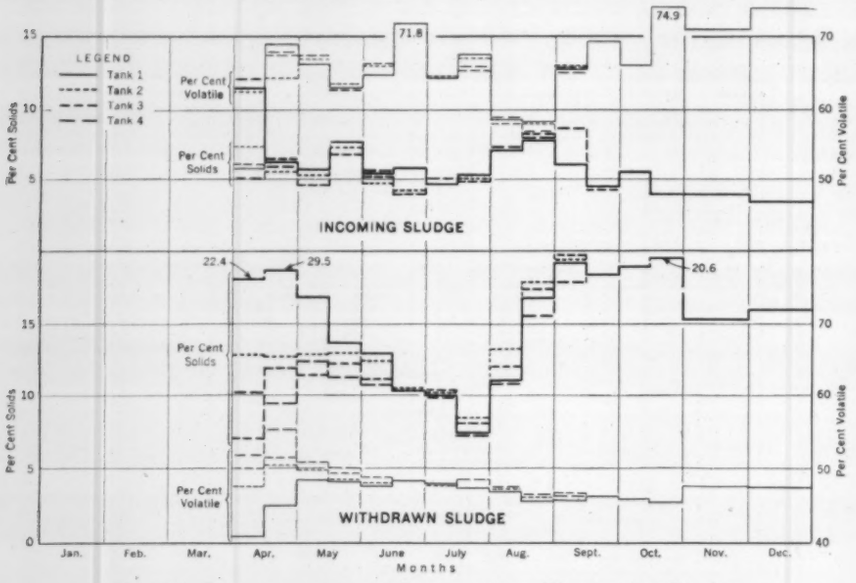

FIG. 3. CHARACTERISTICS OF INCOMING AND WITHDRAWN SLUDGE
Grand Rapids Disposal Plant

TABLE III. MOISTURE CONTENT IN SEPARATE DIGESTION TANKS

PLANT	PERCENTAGE OF MOISTURE: Average Throughout Tank	In Sludge as Withdrawn	Average Below Sludge Level
Grand Rapids	94.6	85.6	89.5
Peoria	96.5	94.6	95.9
Springfield	93.6	87.6	92.2
Plainfield	91.2	90.9	92.5
Salem	95.0	89.5	92.0
Antigo	90.7	84.7	90.3
Sioux Falls	92.7	88.8	91.7
Elyria		94.6	

SLUDGE DISPOSAL

As having a bearing on the operation of sludge digestion tanks, the committee has stated briefly some of the methods of liquid sludge disposal, as follows:

1. By loading it into scows and transporting it to deep water.
2. By loading it into tank wagons or trucks for disposal on agricultural lands.
3. By lagooning, in which a favorably located tract of land is intermittently flooded with sludge until the deposited solids completely fill the area thus used.
4. By broad irrigation, in which again only a favorable local situation may be taken advantage of both as to character of soil and favorable climatic conditions.
5. By discharging into the flood waters of a stream.

Dried sludge is disposed of by the following methods:

1. By selling it as fertilizer or giving it away for the same purpose.
2. By wasting, which means usually that the air-dried sludge is removed from the drying beds and transported to some convenient place where it is unloaded and allowed to accumulate.
3. By using it for fill.
4. By burying, in which case the dried sludge is thrown into trenches and covered with earth.
5. By incineration in specially adapted furnaces or in open piles.
6. Sludge cake from presses or vacuum filters, and air-dried sludge from drying beds, may be loaded into scows and towed to sea for final disposal.

Digested sludge should be removed at frequent, and more or less regular, intervals; and careful records should be kept of the quantity and characteristics of the sludge. The routine operating data which should be obtained are outlined in the report. Special attention is called to the need of determining and keeping records of moisture contents and volatile matter and in particular to the characteristics of the sludge at depth intervals of about 3 ft. throughout the tank.

The separate digestion tanks at Grand Rapids and Elyria were under observation by the committee for a period of six months. At Grand Rapids the digestion tanks receive sludge from combined sewage and from primary tanks with an average displacement period of 2.0 hours. The digestion tanks have fixed covers and are equipped with mechanisms. At Elyria the digestion tanks receive sludge from partly combined and partly separate sewers. The sludge is mixed in the primary tanks with excess activated sludge, both being recovered in the sludge compartments of two-story tanks. The average temperature of digestion was 85.6 deg. fahr. at Grand Rapids and 78 deg. fahr. at Elyria. A solids balance for each plant covering the period of operation is shown in Table IV. In both cases a well digested sludge resulted. The average rate of gas production was 0.79 cu. ft. per capita at Grand Rapids, and 0.5 at Elyria. The major results of operation at Grand Rapids are shown in Figs. 2 and 3. It should be noted that lime sludge from the water filtration plant was added twice during the Grand Rapids observation.

TABLE IV. OPERATING DATA—SOLIDS BALANCE

DRY SUSPENDED SOLIDS	WEIGHT IN POUNDS: Grand Rapids	Elyria
In digestion tanks at beginning of test period*	1,029,050	230,620
Introduced into the digestion tanks from the primary settling tanks† during the test period	3,093,750	679,800
To be accounted for	4,122,800	910,420
In digestion tanks at end of test period	1,331,600	308,060
In sludge removed from the digestion tanks	1,811,990	154,170
In sludge supernatant withdrawn from the digestion tanks	213,260	56,510
In gas as equivalent weight	1,247,895	129,870
Accounted for	4,604,745	648,610
Unaccounted for	481,945 excess	261,810 deficiency

* Grand Rapids test period, June 16 to October 30, 1931; Elyria test period, April 1 to October 1, 1931

† Grand Rapids primary tanks are square and equipped with traction type mechanisms; Elyria primary tanks are of the two-story type.

Present Status of Valuation Procedure

As Applied to Public Utility Properties

By E. B. Black

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PUBLIC utility property in the United States represents an investment of more than fifty billion dollars, and overshadows in its importance all other classes of property in the development of valuation procedure. Valuations made for purposes of taxing, exchanging, or financing non-utility property are of great importance, but the fundamental principles involved are in general the same as those which must be considered in public utility valuation. Mr. Black's paper, delivered on January 20, 1932, before the session of the Engineering-Economics and Finance Division at the Annual Meeting in New York, is limited to a discussion of valuation procedure as it relates to public utilities.

SINCE 1916, when the Society considered the subject of valuation of public utilities in detail, the importance of public utility regulation has materially increased, because of the relative importance of these utilities in our economic life. In this period the number of persons in electrically lighted homes has increased from 22,250,000 to 85,500,000, or from 24 to 70 per cent of the population of the United States; the number of customers using natural gas has grown from 2,450,000 to approximately 5,300,000, and its annual consumption from 795,110,000 million cubic feet, to 1,940,000,000; and the consumption of manufactured gas has doubled. The number of telephones has increased over 70 per cent, and now exceeds 20,000,000 instruments in service, or more than 60 per cent of the world's total. In the same period the mileage of our steam railroads has remained nearly constant, totaling approximately 260,000 miles, while the mileage of street railways has declined approximately 10 per cent, to a total of about 40,000 miles.

The interstate transmission of electric energy and natural gas has developed into a problem of major importance since 1916. The control of interstate transmission of electric energy is fairly well defined, and in cases where the same transmission company distributes to the ultimate consumer, state commissions in the state where the energy is sold take full control of the matter. This has not been true of the interstate transmission of natural gas, which is assuming great importance because of the building of long pipe lines serving gas in cities a thousand miles or more from the gas fields, in competition with other fuels transported by rail and by pipe line.

With the tremendous increase in the number of users of public utility service, there has been a great increase in the number of problems relating to such service, and a multiplication of the difficulties of applying the principles by which a utility is insured a fair return and the users of its service are allowed a fair rate.

The legal right to regulate private property dedicated to public use was first expressed in England more than 250 years ago by Lord Chief Justice Hale, with the proposition that "private property, when affected with a public interest, ceases to be private only." As early as 1877, the Supreme Court of the United States decided that private property devoted to public use was subject to regulation. Since this decision, there has been a practically unbroken line of court decisions supporting the theory of the right to regulate private property "clothed with a public interest," when such regulation is not in conflict with the constitution of the state and the United States.

REGULATION PROCEDURE

The right to regulate private property dedicated to public use lies wholly with the legislative branches of the state and Federal governments. In general, the judicial branches cannot pass on rate matters, except when the rate enforced threatens confiscation of the property involved, in violation of Sections 5 and 14 of the Constitution of the United States.

The powers granted by the various state legislatures to the public service commissions of the individual states are widely different. Few of the state public service commissions have control of public as well as private utilities. In some states, the commissions serve as courts of appeal to which problems having to do with utility regulation are carried from a lower civil court, or from other administrative or legislative bodies within the state.

There is much misunderstanding concerning the fundamental principles of valuation procedure even on those matters in which an engineer presumably is most skilled, as, for example, the determination of the cost of reproduction of a given property. Making due allowance for differences of opinion between qualified engineers on opposite sides in the average valuation case, and granting that both are proceeding in an honest effort to present the facts in the case, the results obtained are frequently too far apart to be susceptible of any reasonable explanation.

To be helpful in valuation procedure, the engineer must have an understanding of some of the fundamental principles involved. This does not mean that he should proceed with slavish conformity to commission and court decisions. The engineer who follows such decisions without a full understanding of their basis, either for the purpose of bolstering up his own opinions in the case, or for use as a background where he has no opinion, is treading on extremely dangerous ground. It is difficult to determine just how much weight should be given certain commission decisions affecting engineering practice, because many principles are evolved in minor cases in which there has been practically no engineering testimony or engineering analyses received or considered.

Court and commission proceedings for some years past have very definitely indicated that while consideration

should be given to investment, to historical cost, and to all other matters pertaining to the value of the property, the cost of reproduction is the item of major importance. Since the World War the trend of commission and court decisions, has been to give little consideration to items other than cost of reproduction.

The theory of the cost of reproduction of a property eliminates consideration of costs based on actual historical sequence. The unit prices in the cost of reproduction valuation should reflect current prices for construction of like character and magnitude, rather than prices derived from piecemeal construction. The cost of reproduction must be sensibly applied and not include purely hypothetical prices which have not been, and probably will not be, incurred in the reconstruction of a property. The importance of the estimate of cost of reproduction with depreciation applied, if any, is apparent when it is realized that utility properties as a whole are not being bought or sold as commodities, and a fair market or exchange value is difficult to establish. Therefore an estimate of the cost of reproducing the component parts of the property is the best measure of its value.

IT is often true that at times when the general trend of prices is downward, the user of public utility service is willing to support strongly the theory of the use of present-day prices for valuation purposes; and that, at the same time, the utility is strongly in favor of adopting average prices over a period of years as the proper valuation basis. When prices are on the up grade, the contrary is often the case. The determination of the trend of prices as of the date of an inquiry requires clear reasoning and sound judgment on the part of the valuation engineer, in order that the result may be fair alike to the purveyor and to the user of utility service.

ESTABLISHED CLASSIFICATIONS OF ACCOUNTS

The Interstate Commerce Commission, and practically all of the state public service commissions, have adopted classifications of accounts for the guidance of utilities in making charges to capital accounts. Utilities generally conform to the established classifications, which serve as valuable guides in the arrangement of the inventory of a property.

In making a reproduction cost valuation, the general rule is that the valuation shall be based on an inventory of the property under consideration, rather than on that of an equivalent property. Utilities seldom have complete property records, and when these are lacking it is necessary to make examinations and measurements of the property in detail, in order to prepare a reliable list of property items.

A proper inventory is a record of the size, quantity, kind, quality, age, and condition of the various items of property under consideration. This should include useful standby equipment. It is sometimes difficult to determine whether or not such equipment belongs in the classification of abandoned and superseded property. An example of such a case is a utility now distributing manufactured gas and contemplating the connection of its distribution system to a natural gas transmission line, with a clause in its contract with the transmission company requiring that it maintain its gas manufacturing plant in operating condition in order to insure continuity and sufficiency of service.

An inventory should also include property acquired for the reasonable future needs of the utility. This is particularly true in the case of natural gas properties, but the extent to which the value of leaseholds located hundreds of miles from the production and transmission systems of a gas company are to be included in the rate base is a matter which must be determined by the best judgment of the court or commission. The usual rule is that property of excessive size or capacity must be inventoried and valued as it exists, with proper deductions made from the reproduction cost for whatever adjustment seems to be necessary because of inability of the utility to fully use such overbuilt facilities.

In the valuation of real estate and rights-of-way, the procedure generally accepted by courts and commissions, and usually followed by valuation engineers, is re-appraisal as of the date of inquiry. The purpose for which the property is to be used; the comparative usefulness of different tracts; the form of the real estate, whether it is in small isolated parcels, large tracts, or whether, as in the case of pipe lines and railroads, it must form a continuous strip from one point to another; all have a direct bearing on the determination of its value.

To determine the unit prices to be applied to an inventory of property in a given valuation, consideration should be given to the trend of prices and to the magnitude of the project. Unit prices should not be based on piecemeal construction. A valuation for rate-making purposes should not be on the basis of distress prices nor of peak prices existing at the date of inquiry.

DETERMINING UNIT PRICES

Unit prices based on prices current in the territory at the time of valuation are much more reliable than those obtained by the application of conversion factors to actual cost figures from the books of the company. There are a number of cost index figures provided in the technical press, by various banking and commercial organizations, and by the U.S. Department of Labor. Also there are comparative index figures for basic materials and some commodities, such as cast-iron and steel pipe. But the application of such indexes to specific property requires rare judgment, or the result may bring confusion to the engineer using them.

Franchise value should not be included in a valuation for rate-making purposes. The cost of acquiring a franchise, limited ordinarily to the cost of a special election for voting on the proposition, is allowed by some commissions as a proper capital charge.

The inclusion of cost of financing in a valuation for determining the rate base requires careful consideration. There is no question as to the necessity of considerable expense in connection with the issuing and sale of securities, either bonds or stocks, and the payment of commissions to brokers. This item of expense recurs whenever refinancing takes place. There is some question as

to whether or not it should be amortized within the life of the security issues, and thus included in operating expenses, instead of being capitalized in the rate base.

Materials and supplies should be included in the valuation of a property for any purpose. The amount to be allowed will depend on the operating experience and requirements of the company and the character of the supplies held in reserve for operating needs. There is no set rule for expressing, in percentage of the physical value of the property, the amount to be allowed for this purpose. Court decisions are generally to the effect that the experience of a normally operated company is the best measure of its requirements.

It is customary in rate cases to allow working capital sufficient to carry the utility through one complete cycle of business operations, and in addition to allow it to maintain a sufficient amount of other capital to continue its business on an efficient basis, by meeting such charges as may be necessary for ordinary operations, the discounting of bills, and the maintaining of bank balances sufficient to fully conform to good banking practice.

THERE are many principles to be considered in valuation, which are not as yet thoroughly established. A broad field is open for the valuation engineer, and whether or not he gains and holds the respect of courts, commissions, utilities, and users of utility service, depends on how thoroughly he investigates the problems involved and how fairly and impartially he makes his decisions.

DEPRECIATION CONSIDERED

Depreciation is generally treated as a lowered capacity for service, and is not, therefore, the equivalent of deferred maintenance or loss of service efficiency. It covers the lessening in capacity for service due to use, inadequacy, obsolescence, accidents, or other causes. The accumulation in the depreciation reserve of a sum equal to a large percentage of the reproduction cost of the property may indicate the fairness of a reduction in the annual charges for this purpose. Depreciation is a matter in which the company's experience, if it has been operating for any length of time, should be the best evidence, and when carefully determined, should be fair to both the company and the public.

Depreciation is determined ordinarily, where practicable, by inspection of the property, and if not by this method, by life tables. An engineering estimate of accrued depreciation should certainly be tempered by inspection, where possible, in order to estimate decretion of value due to the use and maintenance of the items of property involved, but this same estimate is necessarily influenced by the age of the property, its probable future service life, and its adaptability and adequancy for the service it is rendering.

GOING VALUE OR GOING-CONCERN VALUE

"Going value" or "going-concern value," as defined by the courts, is an element of value in an assembled and established plant as compared with one not thus advanced. It is a proper item to allow in the valuation of a property, either for the purpose of financing, taxing, exchange, or rate making. However, it is generally conceded as improper in a rate case to consider testimony as to the amount of going value, when such testimony is based on exchange value.

There is a cost or expense for securing business which a utility entails before it becomes an operating, going concern, and this should be a part of the rate base. The engineering problem is to determine, or at least to suggest, a measure or method for determining the fair-going value of a particular property.

The fallacy of considering earnings in the determination of going value for rate-making purpose is well exemplified by the plight of many of our public utilities during the World War period. These utilities had as much, and in many cases much more, business than at any time before in their history, but operating expenses had so mounted that net earnings were seriously impaired. In such cases, the business was certainly established, but the rate structure was incorrect. Certainly it would have been unfair to penalize a company in this situation, by excluding going value when establishing a rate base.

There are honest differences of opinion as to whether or not going value should be included as an element of the rate base in a valuation. Court decisions have said that going value must be considered, but whether or not an amount shall be included in the rate base for this item depends entirely on the peculiar circumstances surrounding each case. Failure of decisions to provide some formula for the exact calculation of this item discredits its existence in the minds of some of those who would proceed by formula.

DETERMINING GOING VALUE

The fundamental theory of rate making is that a utility is entitled to a return on every dollar honestly and prudently invested in facilities for providing service to the public. After having constructed the physical property of a utility, the owners must make still further investments to attach business, train personnel, acquire operating records, and pay carrying charges on unused plant and equipment during at least a part of the period of development of business, in short to establish the utility as a smooth operating organization after it has been constructed as a physical property.

It appears, therefore, that the item of going value, which the courts say is a value and not a cost, may best be measured by determination of the cost of attaching business. It is obvious that going value cannot equitably be determined by the application of a fixed percentage to the known reproduction cost of a property. In the first place, it is not an element of the cost of reproducing a physical property. It is more nearly represented by the cost of establishing the business attached to a physical property. Unless rare judgment is exercised in computing this value, the estimated cost of attaching business may be so great as to be out of reason.

The Engineering-Economics and Finance Division can make a worthwhile contribution to the profession by emphasizing the importance of engineers' assuming the position of "friends of the court" rather than that of paid advocates for either side in a controversy.

Location of Underground Utilities

Subterranean Street Planning Worthy of Extended Study

By Arthur W. Consoer

Member American Society of Civil Engineers

President and General Manager, Consoer, Older, and Quinlan, Consulting Engineers, Chicago

IMPROPER location of underground utilities and improper construction practices in connection with the installation of sewers, water mains, gas mains, telephone conduits, and the like, are frequently the subject of merited criticism by well informed and observant laymen. This is particularly true in so far as it applies to the frequent removal of street pavement for the purpose of repairing, removing, altering, or adding to underground utilities, and also as it applies to surface defects and structural weaknesses developed in street paving and sidewalks subsequent to the installation of such utilities.

NOTHING arouses the ire of the observant taxpayer quite so much as to find a gang of laborers cutting into a recently paved street to lay or repair the lines of some public utility—water, sewer, gas, or electric conduits. To stimulate thought and discussion among engineers engaged in municipal work, Mr. Consoer presents this article, abstracted from the paper read by him on January 21, 1932, before the City Planning Division of the Society at the Annual Meeting in New York. He urges the necessity of a code for the location of underground public utility structures in each municipality as a part of its master street plan.

Here and there efforts have been made to formulate a code for the proper location in streets and highways of all underground utilities. Rigid standardization on a matter of this kind is not at all possible or desirable, as conditions vary widely in different localities. However, testimony from scores of city engineers, engineers on the staffs of utility companies, water works superintendents, and consulting engineers, indicates that little has been done to formulate and enforce such codes. Most of these correspondents emphasize the urgent need in their localities or regional areas of a suitable code for subterranean street planning.

In a number of the larger cities, boards of underground work have been authorized, comprised of representatives of the municipality and of the various utility companies, usually with an engineer as secretary of the board. Such organizations have performed valuable service in coordinating the work of the municipalities and the utility companies, and in developing proper construction methods, satisfactory locations for underground utilities, suitable permit regulations, and proper maintenance. However, in many instances they have failed to plan far enough in advance. As demands for space and location come in, they are satisfied one by one without proper provision for the correlation of existing underground utilities with those to be expected in the future.

Of course, care must be taken that initial expenditures for construction of subsurface work adequate for future needs are not so high as to overbalance the value of undisturbed surface improvements and the free flow of traffic on the streets.

Some years ago, a committee of practicing engineers working under the guidance of the Chicago Regional Planning Association drafted a "conduit code" intended as a guide for the proper location in city streets and rural highways of sanitary and storm sewers, gas mains, water mains, and conduits for public utilities in the Chicago Metropolitan Area. The recommended location of these utilities in streets 66, 80, and 100 ft. wide is shown in Fig. 1.

This conduit code, as adopted for both city streets and rural highways, contemplates duplication of the various utilities in each street and the elimination of most of the transverse service pipes usually installed previous to the paving of a street. In practice, the telephone company has usually occupied one side of the street and the power company the other, the lateral service trenches being constructed in tunnel.

In the Chicago Metropolitan Area, the Illinois Bell Telephone Company has gone to considerable expense in the past to separate the communication cables from the power cables where the two were brought into close proximity. Naturally this separation becomes more important as the transmission voltage of power

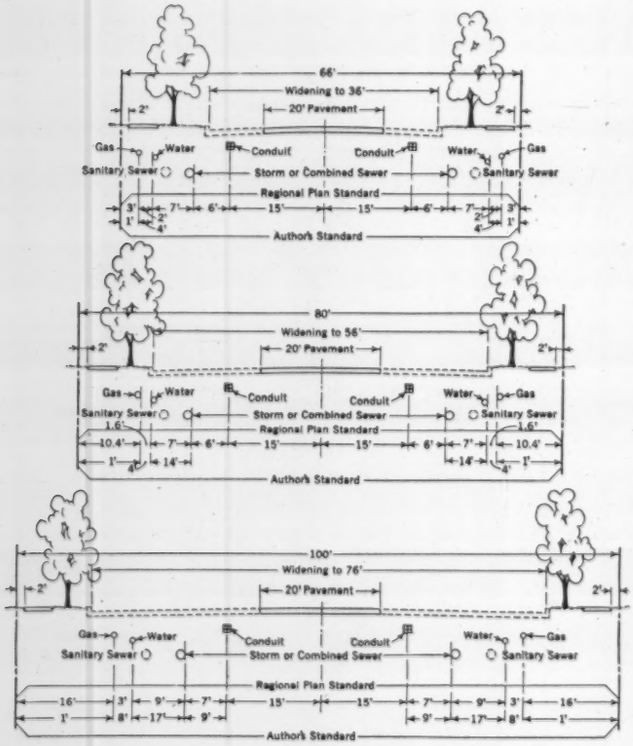


FIG. 1. LOCATION OF UNDERGROUND UTILITIES
Recommended Locations for Duplicate Services

cables increases. Then too, space and depth requirements for manholes for telephone and power cables usually make close proximity of these utilities impracticable.

As shown in Fig. 1, I have modified the locations recommended by the Chicago Regional Planning Association because of construction difficulties encountered in building underground utilities in the limited widths allocated for such work by the Regional Planning Association Code. In unstable soils sheeting will often be needed to follow my recommended locations, especially on 66-ft. streets, and in many cases these locations will be found prohibitive in cost where duplication of the utilities is attempted. In such cases, the central 30 ft. must be invaded or duplication of the utilities abandoned.

A solution of this problem proposed by Ralph A. Smith, Assoc. M. Am. Soc. C.E., is indicated in Fig. 2. His recommendation that telephone and power conduits be placed 11 ft. from the center line of the street, if adopted, will cause more interference to traffic in the central 20 ft. of the street than either of the other spacings shown in Fig. 1, but for average soil conditions it may be more practicable.

DUPLICATE INSTALLATIONS OFTEN ECONOMICAL

In only a few municipalities in the Chicago region have the sewer and water facilities been duplicated at the outset, even on major streets in outlying territories, although there appears to be a trend toward such practice, particularly on major streets and secondary thoroughfares in suburban areas.

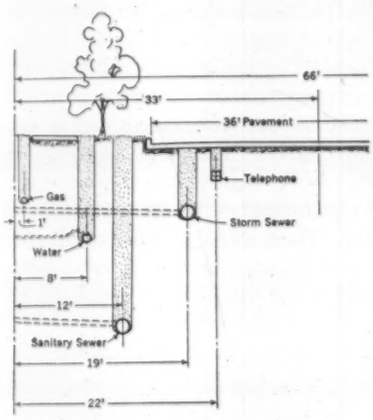


FIG. 2. MODIFIED LOCATIONS FOR UNCERTAIN SOILS

No dogmatic statements regarding the real economy of such practice are possible, because much depends on such variables as widths of streets and building lots, construction costs, topography, and the value of undisturbed pavements.

Following recommendations received from correspondents in the City Planning Division of the Society, it is suggested that the rules listed below be observed where duplication of underground utilities is not attempted:

1. Use one or the other of the two locations shown for each utility. This is for the sake of uniformity and to minimize future cutting of pavements.

2. Place water mains on the north and east sides of streets. Many water works superintendents believe that where the buildings are close together and abut on the sidewalks, frost does not generally penetrate as deeply on the north and east sides as it does on the south and west.

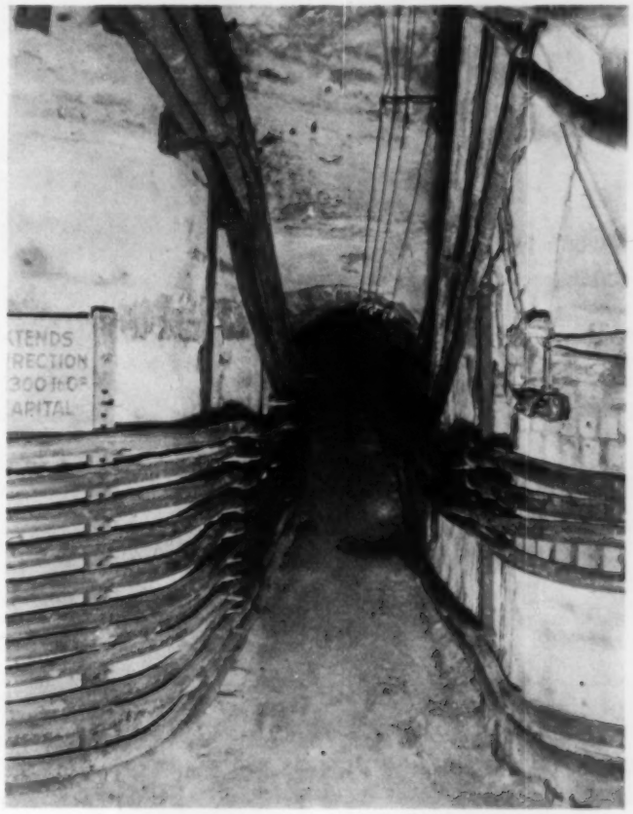
3. Place gas mains on the south and west sides of streets.

4. Place sanitary sewers on the south and west sides of streets.

5. Place storm or combined sewers on the east or north side of streets.

6. Insist that conduits for telephone or electrical service contain sufficient ducts for at least 15 years of anticipated service. When additions are made, they should be sufficient for the demands of 15 years.

7. Do not permit the installation of transverse service pipes opposite vacant property until the street is scheduled for paving.



TRI-STATE TELEPHONE AND TELEGRAPH COMPANY TUNNEL
52 Ft. Below Wabasha Street, St. Paul

8. When a street is scheduled for paving, make comparative estimates of duplicating utilities, as shown in Fig. 1, and of installing the necessary transverse service pipes and give consideration likewise to the many factors favoring the duplication of utilities, especially in cases where few transverse service pipes have been previously installed.

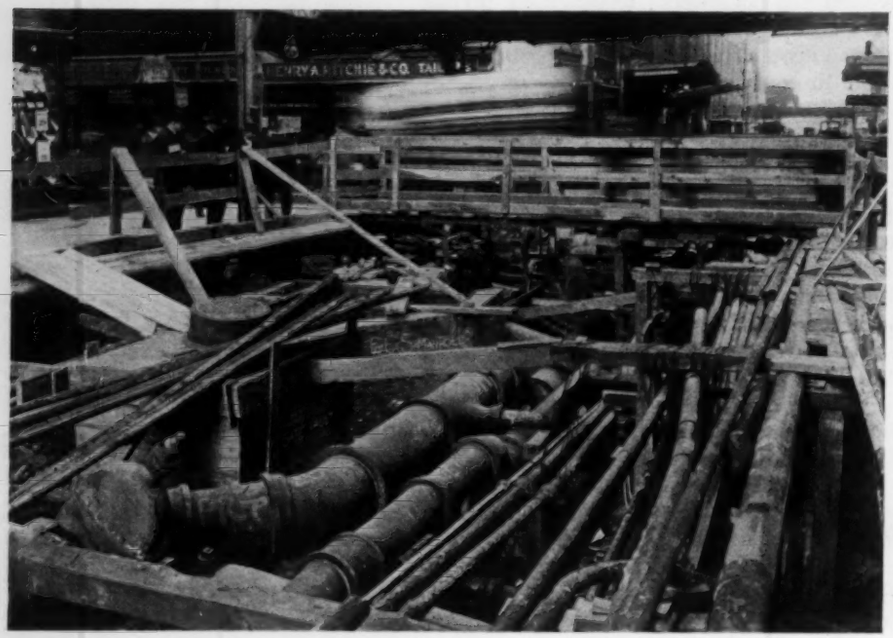
9. Where transverse service pipes are to be installed, make certain that each vacant lot is served by all underground utilities and that such services are located approximately at the middle of each lot.

10. In any event, all underground utilities deemed necessary for 15 years to come should be installed well in advance of paving construction.

11. In the central city or regional offices, keep careful map records of all underground utilities, including those installed by private corporations. Permits issued for installing underground utilities, and contracts let for the construction of sewers, water mains, gas mains, and the like, should be carefully followed up to insure the accuracy and completeness of such map records.

Pneumatic tubes, steam lines, and other utilities not

shown in Fig. 1, ordinarily will be installed only on important streets in business districts. On 80 and 100-ft. streets, standardized locations for such utilities can be easily assigned, in the spaces between the property lines and the gas-main locations. Where such utilities are needed on streets 66 ft. wide or narrower, the problem becomes complicated, for either recourse must be had to utility tunnels built under the sidewalk spaces, in the locations marked in Fig. 1 for gas mains, or else the paved street area must be invaded.



PUBLIC UTILITIES ENCOUNTERED IN SUBWAY CONSTRUCTION
Dey and Church Streets, New York

ST. PAUL UTILITIES IN TUNNELS

The utility tunnels in St. Paul are worthy of special mention as evidencing skill and foresight in underground design. I am indebted to George H. Herrold, M. Am. Soc. C.E., Managing Director of the City Planning Board of St. Paul, and to O. H. Hosmer, Assistant Engineer of the board, for information on, and photographs of, the St. Paul utility tunnels.

In the principal business district of this city a soft sandstone stratum is in close proximity to the surface, within about 20 ft. of it. This formation has made possible the extensive and economical use of tunnels for housing underground utilities. Such utilities as electric light and power, telephone, heat, water, and sewerage are served from tunnels in this sandstone. In Fig. 3 is shown a typical cross section of a street in the central business district of St. Paul, with the relative positions of the utility tunnels.

Ventilation is secured by shutter regulation at the point where the tunnel system opens on the river gorge. Sufficient air is permitted to filter through the tunnels to provide healthy working conditions.

Disintegration of the sandstone under these conditions, which are very different from exposure to the elements, takes place very slowly. The amount of cleaning or removal of disintegrated stone required varies with the use of the tunnel and the amount of construction work done in it. In the cable tunnels of the Northern States and Tri-State Telephone and Telegraph Company, cleaning near the entrance is required about four times a year, but in the outer branches one yearly cleaning is sufficient. Steam pipes for heat service, which are housed in similar tunnels, are laid either directly on the floor or on supporting brackets. Heat tunnels require more frequent cleaning. In the case of sewer tunnels, storm water flows flush the paved invert sufficiently to wash out disintegrated sandstone.

The friable characteristics of this sandstone and the absence of groundwater difficulties make possible unusual economies in the driving of these tunnels. The pick and shovel are the only digging tools required. Practically all the sandstone tunnels and sewers in the central business district of St. Paul are 3 ft. wide by 6 ft. 6 in. high.

In larger cities the placing of underground utilities will be affected by the proposed location of rapid transit subways, and in many places by the probable construction of pedestrian subways. In the proposed new State Street subways for Chicago, a space $3^1/_2$ or $4^1/_2$ ft. high between the street surface and the roof of the transit subway has been assigned to the utilities. This narrow headroom will necessitate the location of telephone and power cable

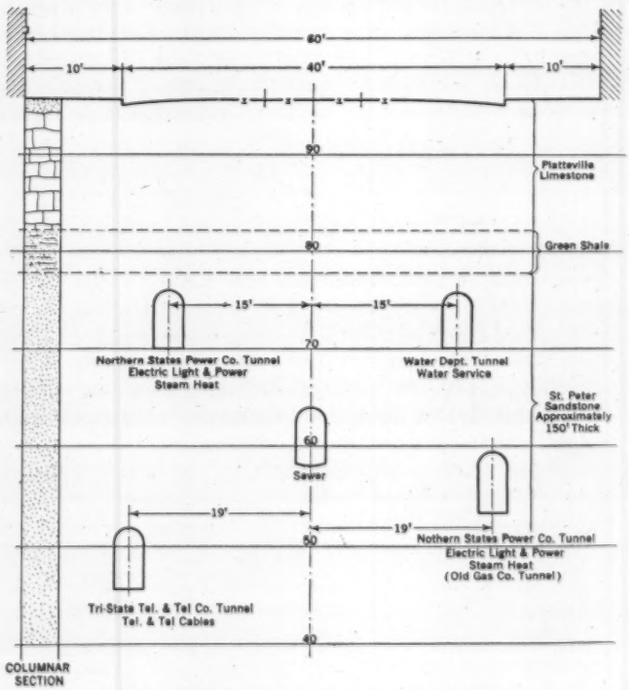


FIG. 3. UTILITY TUNNELS IN ST. PAUL
Section Through Fourth Street at Wabasha Street

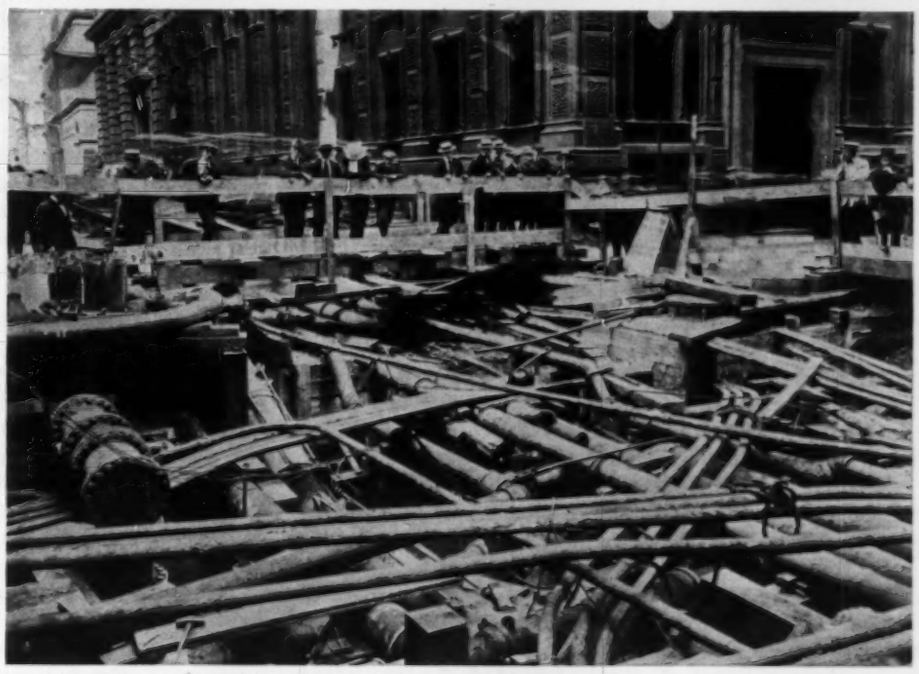
manholes on intersecting streets, the cables being bent into such manholes from State Street.

A full discussion by members of the City Planning Division of the various factors involved in the proper location and safeguarding of underground utilities should result in the assembly of sufficient data to make possible the preparation of a "Manual on the Proper Location of Underground Utilities." Most cities have developed a major street plan to govern such matters as street and pavement widths and the proper location of civic centers, schools, parks, playgrounds, transportation facilities, railroad stations, and boulevards. The free, unhampered flow of vehicular and pedestrian traffic on major streets and secondary thoroughfares is promoted by the development of such a plan.

Of almost equal importance for cities and regions, and for rural highways as well, is the matter of subterranean street planning. Underground utilities frequently cost as much as, or more than, surface improvements on streets and roads. If a major street plan is needed, then a conduit code or master plan for the logical and satisfying location of all underground utilities is also required.

Testimony from scores of large cities and utility companies is to the effect that no definite rules have been laid down to govern either the location or the construction of underground utilities, even in general principles. It would seem that most of these agencies would welcome the publication of a Manual of Practice on this subject, to provide guidance in the preparation of master regional or city plans for the location of underground utilities. The development of the major street plan and the master plan for the location of underground utilities should be coordinated by a plan commission or other competent authority.

Much of the mounting tax burden in American cities is due to lack of proper planning. No small factor in the taxpayer's burden is the lack of proper control of the location and construction of subsurface improvements.



A TANGLED MAZE OF UNDERGROUND PIPES
Wall and William Streets, New York

PRINCIPLES OF SUBTERRANEAN STREET PLANNING

Codes similar to that already adopted by the Chicago Regional Planning Association can undoubtedly be applied with advantage to the newer areas in other regions. Among the general principles which should be used in subterranean street planning, the following might be mentioned:

1. A subterranean street plan should be developed with the cooperation of all interested public and private corporations, preferably as a regional planning effort.

2. Central control and records of underground work are desirable.

3. Issuance and supervision of permits for all work on underground utilities should be cleared through the central planning body.

4. The central planning body should be financed by all the public and private corporations interested. This will tend toward efficient, nonpolitical administration.

5. Efforts should be made to promote the free flow of traffic and to reduce costs for reconstruction work on both pavements and underground improvements.

6. Utility tunnels should be used where economically feasible.

7. Street grades must be studied as to their influence on the location of underground utilities.

8. Subterranean planning should be coordinated with ordinary city planning.

9. Underground utilities should be placed with regard to the location of traffic lanes on the surface of streets.

10. Unnecessary crossings from side to side of any street or highway by any underground utility should be avoided. The duplication of utilities, on major streets at least, should be given careful consideration, especially in areas not fully developed.

In a controversial subject, such as the location of underground utilities is certain to be, more will probably be accomplished if agreement is first reached on a set of general principles. Hard and fast standards, hastily adopted and concerned with details, may retard rather than aid progress, particularly if detailed standards become subjects of legislation.

In any region, after an agreement has been reached on the general principles to be adopted, the subterranean planning can proceed to the development in detail of flexible practices, and to the adoption of a reasonable master subterranean plan in coordination with the master street plan.

Geodetic Control for North Carolina Highways

Its Advantages and Probable Effect on Engineering Practice in the State

By GEORGE F. SYME

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

SENIOR HIGHWAY ENGINEER, STATE HIGHWAY COMMISSION, RALEIGH, N.C.

A NEW form of state and Government cooperation is undergoing successful trial in North Carolina, where the U.S. Coast and Geodetic Survey is making comprehensive surveys for the specific use of the Highway Department. The resulting coordination will enable all road projects to be tied in accurately and at the same time will give a base net, both horizontal and vertical, from which all surveys throughout the state can be extended. The possibilities of the future application of these efforts are detailed by Mr. Syme. His paper was delivered before the Surveying and Mapping Division on January 21, 1932, at the Annual Meeting.

AS A RESULT of action at its January 1930 convention the North Carolina Society of Engineers sponsored a bill in the state legislature aiming to secure the immediate completion of the triangulation of the state by the U.S. Coast and Geodetic Survey. Although the measure did not become law, the agitation had great educational value, so that the State Highway Commission, quick to visualize the possibilities of geodetic control for state highway surveys, on September 2, 1931, unanimously authorized the appropriation of funds sufficient to secure a complete triangulation of the state with Government cooperation.

Shortly afterward a contract between the commission and the U.S. Coast and Geodetic Survey was entered into, by which the Survey agreed to perform the work with all possible speed and to bear the major part of the expense. The time required was estimated at two years. This survey is now under way.

COMPREHENSIVE SURVEY OF STATE

The state will be divided into areas by first-order triangulation arcs at intervals of about 100 miles, and these will be cut by second-order arcs, so that there will be no point in the state more than about 25 miles from one of the triangulation stations. All arcs will be rigidly tied together and adjusted so as to furnish final geographic positions of great accuracy. Lines of first- and second-order levels will be run. Like the triangulation, these will be distributed over the state so that no point will be more than 25 miles from a bench mark.

Each triangulation station will be monumented with the Survey's standard monument, and an azimuth mark will be placed within 1,200 to 1,500 ft. of each station, ready for use by the local surveyor. In addition, supplementary triangulation stations will be established close to each main highway and each county line crossed by the triangulation arcs. The Survey's standard bench marks will be set at intervals of about two miles along the lines of levels, and in addition at least two bench marks will be established in each incorporated city or town. A bench mark will also be placed at each important railway and highway along the routes.

After the work is completed and adjusted, the results will be published by the Survey in pamphlet form for public use.

It is the intention of the Highway Commission to build up a supplementary system of monumentation, which will be tied to the triangulation net. As many of its surveys as possible will start from, or be tied to, a geodetic station. Such surveys will be more accurately made than heretofore and will be carefully checked and monumented so that other surveys can be tied to, and based upon, these monuments, and in turn become a part of the state system. Although specifications for these surveys have not yet been written, it is certain that work of less accuracy

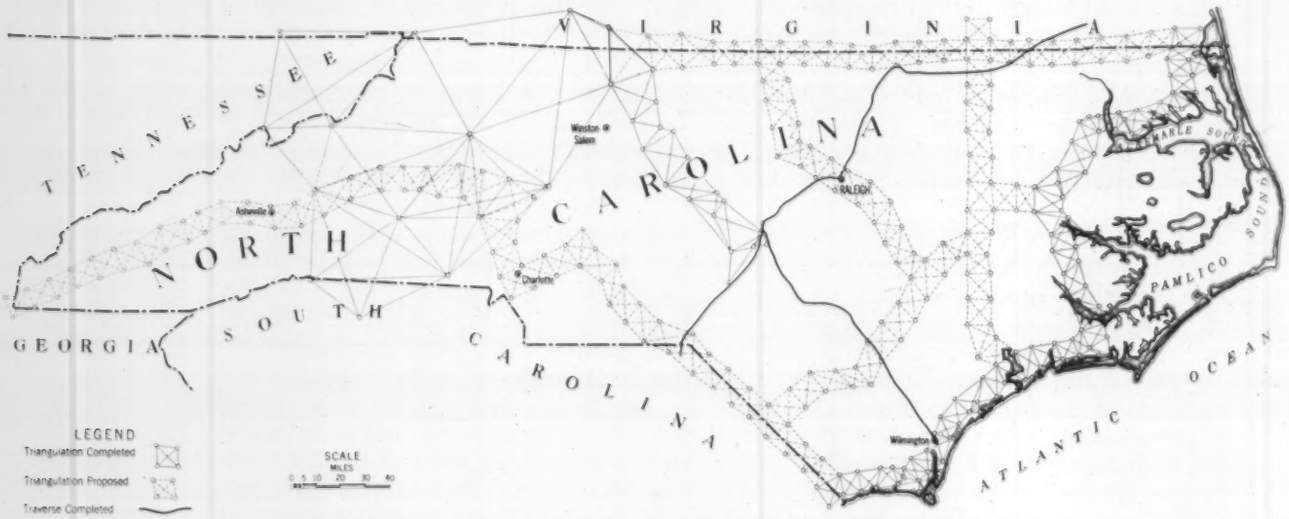


FIG. 1. COMPLETED AND PROPOSED TRIANGULATION NET FOR NORTH CAROLINA
As Planned by the State Highway Commission in Cooperation with the U.S. Coast and Geodetic Survey

than 1:5,000 will not be incorporated in the system. Thus, in a few years, monuments available for all surveying purposes will be conveniently located throughout the state.

At first thought it might seem that it would require many years to complete this supplementary monumentation, but the additional stations which the Coast and Geodetic Survey will place near each county line and main highway will greatly facilitate the rapid consummation of the work. In addition, the Highway Commission may confidently expect substantial assistance from many sources. Other state departments, counties, municipalities, corporations, and individuals will make use of the geodetic and supplementary stations, and many of their surveys will be monumented with standard supplementary monuments, thus extending the system. Furthermore, nearly all the engineers in the state are intensely interested in the work and their enthusiastic cooperation will be a great asset.

It is highly probable that the North Carolina Society of Engineers will next sponsor and work for a complete topographical survey of the state by the U.S. Geological Survey. If its efforts are successful, the monuments of that survey will of course become a valuable part of the general monumentation scheme.

PRACTICAL ASPECTS GOVERN

Why does the Highway Commission desire geodetic control for its surveys? What advantages will it derive from such control? What prompted it to take this unprecedented action? The answers to these questions may be inferred from the following description of its previous methods of surveying and mapping highways, which methods I fear are practiced in many other states today.

In building our state highway system it was necessary to carry on the work in short disconnected sections, or projects, of from about 5 to 12 miles in length scattered throughout the state so that all communities could profit alike from the road program. The system consists of nearly 10,000 miles of roads, which have required 11 or 12 years to construct. Based on an average length of projects of 8 miles, about 1,250 separate final location surveys had to be made, not to mention numerous preliminaries, revisions, abandoned locations, hundreds of surveys for bridge sites, and about 1,250 sets of detailed plans, each consisting of from 10 to 100 standard-sized sheets.

Generally the procedure was to take the magnetic bearing of the first course as a base from which all other bearings were computed, while the levels were started from a bench mark whose elevation was assumed. The bench marks were usually chopped in the root of a tree, or indicated by a spike driven in a telegraph pole or other perishable object.

COORDINATION ELIMINATES INCONSISTENCIES

It is evident, therefore, that when two such project surveys meet from opposite directions we obtain the absurdities of two different computed bearings for the same tangent at the point of junction, and two different elevations at that point. Neither of these elevations has any meaning with reference to elevations on any other highway because each is based on an assumed datum. Furthermore, unless the alignment is carefully referenced to lasting monuments and the bench marks are on permanent objects, it soon becomes impossible to reproduce accurately these otherwise wholly unsatisfactory surveys. This difficulty alone has often caused much embarrassment and expense.

Blue prints and field notes of such surveys serve only for construction purposes and in a few years become almost entirely worthless. Imagine the tremendous economic loss of 10,000 miles of highway location, costing a million or more dollars, which after construction are utterly valueless for future accurate use! It is like casting priceless by-products of a great factory into the sea.

Maps of the highway system, based on such surveys, cannot be expected to represent other than a crude picture. Likewise, county lines, towns, streams, and railways are only roughly sketched and their true positions are unknown. Such maps are devoid of meaning when the relative positions of any two points in the state are desired. The bearing and length of a line between such points can only be determined by an expensive, time-consuming survey.

When our future surveys have been subjected to horizontal and vertical control and monumentation, each will become a part of the state system. Each can be easily and correctly reproduced at any future date and from it other surveys may spring and become a part of the common system. Thus in a short while these surveys will form a composite structure, each in its true position with reference to the others, with the result that maps of our highway system will gain a new value.

In the matter of bridge site surveys, vertical control on mean sea level datum will greatly facilitate the securing of data on the plan and profile of streams. Where this control is lacking much costly field and office work is necessary. Backwater conditions and highwater elevations along a stream are easily and accurately determined if all projects are vertically controlled, but they require much time and present many opportunities for mistakes if each project is based on a different, assumed datum.

EXTENDING PRESENT USE

The State Highway Commission considered and justified the appropriation for this survey strictly from a highway standpoint, although of course it was also cognizant of the tremendous profit that would accrue to other state departments, counties, municipalities, corporations, and property owners. The commission will make use of the triangulation stations and bench marks as soon as possible after each has been established, and will carefully check and monument its own surveys, but as yet plans have not been perfected for the general utilization of the system by individuals. Such plans will however be developed and put into operation before the triangulation is completed.

Possibly some sort of general mapping agency, armed with the necessary authority but not connected with the Highway Commission, will be set up at Raleigh. This will serve as a clearing house to write specifications; to collect and preserve all worthwhile survey data from all parties who use the system; to check all computations of such surveys, discarding those which do not meet the specifications; to map the correct location of county lines, corners, streams, and railways, as they may be

determined from time to time; to erect monuments on satisfactory surveys made by parties who fail to monument their work; to control all monumentation; to furnish the public with any information desired; to keep an accurate, up-to-date state map and other records showing the position of all monuments; and to perform the many other duties that will develop as the monumentation is expanded.

PLANE COORDINATES FOR UTILITY

Since the geographic position of each control station will be known, plane coordinates will be used in our future surveying and mapping operations, for their use is logical as well as very simple. However, the length of the State of North Carolina in an east and west direction is so great that it probably will be advisable to have more than one plane system, each being centered on a control station. These plane systems are not limited as to their north and south extent, but they must be restricted as to their width, east and west, according to the degree of accuracy required.

The following tabulation, derived from Special Publication No. 71 of the U.S. Coast and Geodetic Survey, gives the limiting widths of belts for plane systems which may be used under several requirements of accuracy, it being understood that the origin of coordinates is to be at a control station at the mid-point of an east and west line across the belt:

WIDTH OF BELT IN MILES	ERROR DUE TO USE OF PLANE COORDINATES
37.2	1 part in 100,000
49.8	1 part in 50,000
80.0	1 part in 20,000
111.8	1 part in 10,000
159.0	1 part in 5,000

Evidently it would be possible to extend the plane coordinate system over the entire State of North Carolina with the use of four different origins and still maintain an accuracy of 1 part in 5,000. In each of the large cities of the state, where greater accuracy is desired, it would be necessary to have a local origin. In some cases this local origin may coincide with one of the origins for the state as a whole.

In using the plane system, whether one or more belts are employed, records should be made showing the relation between plane and geographical coordinates of certain control stations so that in the future there may never be any doubt as to the exact location of any point or corner.

EFFECTS ON FUTURE ENGINEERING WORK

The completion of our fundamental and supplementary control systems and their use by the State Highway Commission presages the dawn of a new day for surveying work in North Carolina, and we confidently predict a far reaching and beneficial effect upon our engineering thought and education as well. Those predictions are based upon the fact that the engineers in the state, almost without exception, as well as those of the Highway Commission, have shown their recognition of needed improvements by their whole-hearted endorsement of our plans for a horizontal and vertical control system. This clearly shows that the time is at hand for a general housecleaning in our surveying practice, and it now seems certain that practically all important future surveys in the state will be controlled.

There seems to be little doubt but that the subject of surveying, despite the fact that it is one of the main foundation stones upon which rests the whole profession of civil engineering, has been relegated to a neglected corner in the curriculum of some, I fear many, of our engineering colleges. This may, at least in part, account for some of the chaotic conditions which we encounter daily in the practice of surveying.

Such terms as geodetic control, geographic positions, first- and second-order arcs, triangulation nets, precise levels, horizontal and vertical control, spherical coordinates, U.S. Coast and Geodetic stations, parallels, longitudes, and all the rest, seem to stun the average engineer, who has been accustomed to work only along the beaten path. This is merely because he has not had occasion to think in these terms or to work with these tools. Given one day's experience, he will find that they are as simple as the terms he has been accustomed to, and that the methods involved are simpler and much more logical than he ever dreamed. In fact, the differences between the two methods are simple enough. Formerly elevations were based on an assumed datum, computed bearings were based on a magnetic course, and a protractor was generally used in plotting the work. In the case of controlled surveys, elevations are based on mean sea level as the datum; true azimuths, or true bearings, are obtained at a control station; and plane coordinates referred to the control station are used in plotting.

However, in the first case, the survey generally serves only the one purpose for which it was made and often in a few years it becomes lost beyond hope of recovery. With the new method it is indestructible. If the corners are destroyed they can be easily replaced and the survey can be utilized for many purposes, like the by-products of a factory. The local surveyor need no more concern himself with the intricate calculations and delicate instrument work performed by the U.S. Coast and Geodetic Survey in preparing the system for his use, than a man driving over a bridge need be concerned with the detailed computations of the engineer who designed it.

COOPERATION BRINGS SUCCESS

The advantages to the state of controlled surveys are too many and too obvious to need enumeration. Suffice it to say that by means of the appropriation of an inconsequential sum by an intelligent highway commission, the state expects within a few years to mass data of unlimited value.

Any account of this work must acknowledge the splendid cooperation so cheerfully given by the U.S. Coast and Geodetic Survey to the engineers in North Carolina in their effort to secure geodetic control for the state. This remarkable Government organization, recognized around the world as the highest authority in its many lines of scientific endeavor, is anxious to serve. Engineers who form contacts with it may be assured of courteous and valuable assistance in handling their problems.

While the North Carolina Society of Engineers conceived the idea and sponsored the movement for controlled surveys, credit for the final accomplishment belongs to the brilliant chairman of the Highway Commission, the Honorable E. B. Jeffress.

Place of Surveying in Engineering Education

Taking Advantage of the Educational Opportunities Offered by the Summer Camp

By J. K. FINCH
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MANY engineering schools are content to teach surveying as simple "field geometry" and attempt only to familiarize students with "handling" surveying instruments. Professor Finch believes that surveying can and should be taught as a production process and on a production basis. He pictures, in particular, the summer camp as offering an opportunity, unparalleled in any other engineering course, for teaching by actual practice the engineering and economic principles of organization and production. This is an abstract of a paper presented by Professor Finch before the Surveying and Mapping Division on January 21, 1932, at the Society's Annual Meeting in New York.

IT is entirely feasible to teach surveying in preparation for a career as a surveyor, but this problem appears to be primarily one for the junior college or technical high school. Studies of private surveying organizations show, in general, that only those men occupying executive or administrative positions are engineering college graduates. Young men, usually with no previous education beyond high school, who have secured their surveying training through apprenticeship, night courses, or other vocational channels, make up about 95 per cent of the field and office forces engaged in surveying operations. Any substantial improvement in the technic of surveying practice must therefore be based on improved facilities for training this type of man.

On the other hand, surveying is a well recognized educational element in the curriculum of every engineering school or college. It is the place of surveying in the program of what may be called professional engineering training—the type of training, presumably, to which our engineering colleges devote their efforts—that will be discussed here.

At the meetings of the Surveying and Mapping Division there has been almost invariably some criticism of surveying instruction as carried on by our engineering colleges. Much of this is justified. Too often this subject is taught by the blotting-paper method, in which students learn to absorb rather than to produce. Almost invariably surveying is given to the youngest and least mature of the students, that is, to the freshmen, by the least mature members of the faculty, that is, by the youngest and most inexperienced instructors on the staff. So-called field practice too often consists of a series of kindergarten exercises planned to familiarize the student with the effect of turning this screw or that. Almost without exception the possibilities for developing independent thinking and resourcefulness, as well as an ability to organize and to produce, latent in this most ancient engineering branch, are completely neglected.

A PRODUCTION PROCESS

By the great majority of textbooks and teachers surveying is approached solely as a series of exercises in "field geometry," a misnomer frequently applied to the subject. As a matter of fact, surveying is a production process, subject to the same type of economic analysis as any manufacturing activity. It is perhaps the only engineering school course that can be carried through to a finish on the production basis. The neglect to do so results in the loss to the student of an educational opportunity which is not paralleled in any other engineering school course.

How can surveying be taught as a production process? There are three methods of conducting instruction in surveying, as follows: (1) classroom exercises, (2) campus practice, and (3) field practice at a summer camp. All three of these methods have values which cannot be neglected in planning a course of study.

Although there has been a trend in recent years toward requiring field practice in surveying during the summer months, every effort should be made to use the summer camp most effectively and to reduce, to the minimum consistent with thoroughness and a reasonable scope, the time required for this work. As much as possible of the so-called summer vacation should be used by all engineering students to secure experience by engaging in a minor capacity in actual engineering practice. Also, to the average student, the financial return from such efforts is essential in meeting his college expenses.

This means that no classroom exercises or work that can be done on the university campus during the regular academic year should be carried over to the period allotted to summer field practice at a surveying camp. It is argued that much basic instruction can be given most effectively at the summer camp. While this is undoubtedly true, the problem to be faced is that of utilizing most effectively the students' time and it cannot be argued that the summer can best be used for work that might otherwise be even less effectively handled in the classroom.

In short, the classroom exercises must be envisaged as meeting the requirements for preliminary instruction and discussion of principles and methods; the campus practice as a means of familiarizing the student with surveying instruments; and the camp field practice as the means of utilizing the information that has been acquired, under conditions and requirements which parallel those of actual engineering practice in actual production.

At the present time, photographic and aerial surveying form closely related specialties. Although an increasing amount of work will be handled by these methods, it is clear that, at least for many years, this will not be done by civil engineers in general practice but by specialists. There is no room in a general engineering course for such

instruction, but the student should be advised of the general principles, advantages, limitations, and conditions under which such methods can be economically employed.

SCOPE OF INSTRUCTION

Geodetic surveying falls in a totally different category. The history of surveying shows that improvements in plane surveying have almost invariably come through

PRACTICAL WORK AT A COLUMBIA UNIVERSITY SUMMER CAMP

the adoption of previously established and proved geodetic methods in plane surveying practice. In general, the engineering school is expected not only to instruct in current engineering methods but also to give its graduates a training on which the improved methods of future practice can be based. Elaborate and complicated astronomical training is out of place, but the methods of geodetic triangulation and precise leveling cannot be neglected. These methods, in modified form, are now used to some extent in plane surveying practice and will be more extensively used in the future. Their control values in extended topographic surveys should be illustrated by coordinating this work with the topographic problems. A topographic map covering eight square miles has been made by compilation from over 200 individual student surveys by transit and stadia and plane table methods. A well developed system of triangulation and coordinates as well as levels, all carried out by students, was used in this work.

CLASSROOM METHODS

In the classroom the essential things are the manner of teaching and the personality of the teacher. Recent studies have shown that a student grasps and retains descriptive matter through reading a well written and illustrated book quite as well as, if not better than, he does through listening to a lecture. Proper economy in teaching therefore requires that in many cases lectures be abandoned and properly prepared material be furnished in advance to the student. In surveying, for example, all matter descriptive of instruments and methods can be given the student as "home work." The classroom period can be better used in arousing a healthy spirit of investigation into the engineering and economic features of surveying as a production process. Such subjects as economic principles, the balance in values between increased accuracy and its accompanying increase in cost, the organization of field parties, and the problem of adapting methods to the caliber of the men to be employed, all furnish vital topics, which prove that surveying is far from being simply "field geometry."

A student who is participating in such a discussion cannot take notes. These should be prepared by the instructor beforehand in multigraph form and handed around at the close of the period. Obviously the instructor must know in advance the essential facts that are to be brought out by such class discussion, and must lead rather than monopolize it. The student's entire time and attention are essential to the proper use of classroom periods. For this reason I advocate the fullest possible utilization of modern mechanical aids as a means of imparting and recording essential information. On the other hand, the mechanization of classroom technic is absolutely fatal if we want to stimulate thinking and bring out the basic principles of engineering analysis.

CAMPUS PRACTICE

Many schools, limited by urban conditions and inadequate appropriations, have been content to restrict their field operations to campus practice. At the worst, such work is simply a means of employing the student's time in a healthy outdoor pastime; at the best, it can be a fairly effective method of familiarizing him with surveying instruments and the simpler measuring operations. Under no conditions I know of can it be made an effective means of teaching surveying on the production basis. For this teaching, the summer surveying camp is an essential adjunct to the engineering school.

On the other hand, the economical use of the student's time demands the most effective methods of campus practice. Here the operations of adjusting and setting up the instrument, reading and recording bearings and angles, carrying on azimuth, and measuring single distances—in short the simpler aspects of surveying that may be isolated in a series of short exercises—can be handled in a fairly effective way.

POSSIBILITIES OF THE SUMMER CAMP

When the student who has had the required classroom and campus training comes to the summer surveying

camp, he is prepared, but not competent, to put his knowledge into practice in complete surveys. The camp work should be organized therefore as a series of separate surveys, each complete in itself and, as far as possible, similar to a regular surveying operation in which the student is held to the standards of general surveying practice. For this work the student must join a party of, say, three young men, and the work must be done by the piece system, that is, on a production rather than on a time basis.

It must involve not merely the spending of a fixed number of weeks at the camp but the completion of the required number of surveys of standard accuracy. Seldom is it difficult to make the student thus responsible for his own time. On the satisfactory completion of its particular task, each party is advanced independently of other parties, in order to encourage a healthy spirit of competition and a desire to be the first to finish. The loafer who wastes his time simply fails.

Every student and every party should be required to keep time and cost records of their work. These can be computed, using a standard unit price per man per day for field and for office work, on an acre or a thousand-foot basis. The results should be posted on the general bulletin board to encourage competition. In addition, they give essential data on the relation of field and office time, on accuracy and cost, and on the relative advantages of one method over another. Summarized in tabular form each year, they furnish valuable data, with proper allowances for inexperience, on estimating the cost of surveying operations. The so-called heresy that it is economical to work so fast that 10 or 15 per cent of the measurements must be repeated also becomes obvious. The "earnest and industrious student" discovers that his apparently less studious confrère perhaps can excel him on production.

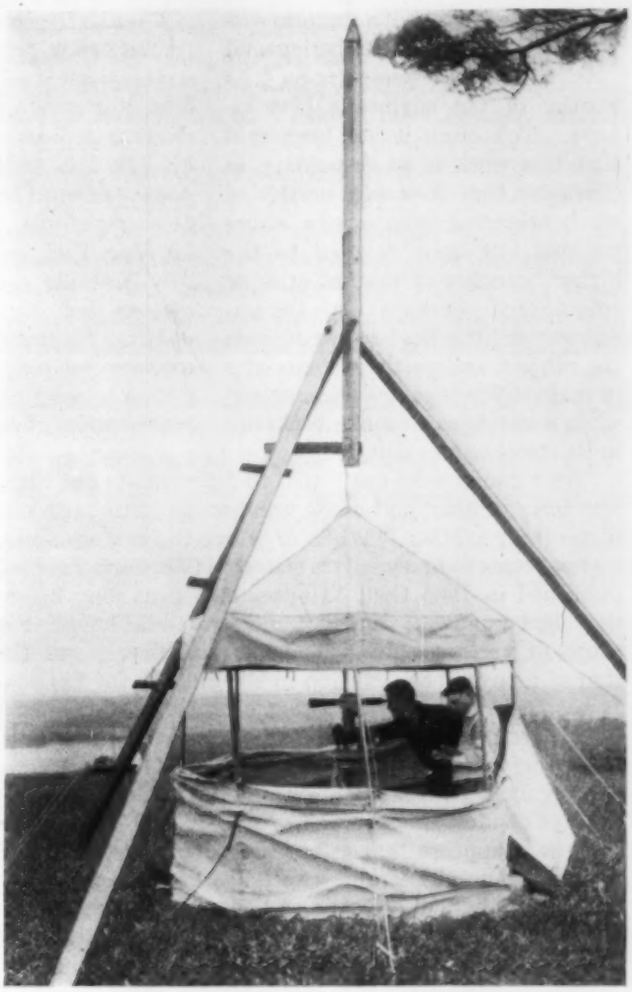
For each of these surveys complete preliminary instructions in the form of printed notes are essential. The instructor, however, should not follow the parties into the field and assist in the operations. The students are put on their own mettle, and their resourcefulness must overcome the obstacles always encountered in the field. The instructor merely "visits" a field party once or twice a day to offer suggestions and correct bad habits in the use of the instruments.

COMPETITION AND CHARACTER BUILDING

Every survey made by the student should be carried through to the complete map and reports while at the camp. Finally, in the opinion of all those connected with courses in surveying, the summer camp offers social advantages and gives opportunity for character building and for stiffening the student's determination and will power.

Obviously the advantages of getting a group of young engineers in a camp, far away from the distractions of urban life, are particularly important for the engineering school in a large university—a type of educational center which must of necessity be located in or near a large city. Esprit de corps is no idle phrase in engineering organizations; when young engineers work and play together in the intimate life of a summer camp they are imbibing the spirit on which successful engineering organizations are built. There is also an opportunity for them to see and understand some of the problems of camp life—problems they will later meet if they go into field or construction work.

Furthermore, it is undoubtedly true that the great number of young men who entered universities in the years following the war represented a lower general average than the students of the previous decade. These younger students had not entirely escaped the effects of the changed point of view of the new era. The rapid



ONE WAY TO SPEND A COLLEGE VACATION

mechanization of labor, with standardized hours of work and compensation unrelated to ability or production, the monotony of army life, and the fact that in such surroundings it was unnecessary to make any special effort to secure the necessities of life, were influences which left their imprint on the new college generation. The type of student who "watched the clock" and was apparently as well satisfied to make an excuse as an answer, increased in numbers. In some cases, more prodding and heavier penalities have sufficed to correct the situation; in others, a little judicious back-patting, even for only fair results, has stimulated better efforts. In all cases, the spirit of competition with one's fellows, essential in sport and in life, and characteristic of the summer camp, has been a vital factor in turning out resourceful young engineers, young men of initiative possessing that quality known as "self-starting."

Street Names and House Numbers

Review of Systems Proposed and in Use, with a Recommended Uniform Plan

By J. P. Schwada

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TO FIND a house number in your own city often proves to be a task, but in a strange city it may require the combined help of a street car conductor or a taxi driver, a policeman, and several passers-by. In this article, abstracted from a paper presented before the City Planning Division of the Society at its Meeting in New York on January 21, 1932, Mr. Schwada outlines several available systems and discusses their flaws and merits. He stresses the desirability of a uniform yet simple plan, and presents a street naming system of his own for the consideration of engineers.

THE planning of a uniform system of house numbering and simplified street names is worthy of the engineer's best efforts. Too often it has been said that this work is so elementary in character that it is not worthy of much attention from a man whose training has been devoted to the higher branches of mathematics or engineering. Perhaps this is the reason why so little has been written on the subject, and partly explains why so many difficulties are encountered when a city tries to make a change in its street names and numbers.

Street names were originated to differentiate one highway from another, and house numbers to distinguish one house from another. When or where the custom arose, no one seems to know. It is stated in *Chamber's Journal*, published in 1865 that, "Houses had signs long before they had numbers; and not merely public houses but shops of various kinds. The 'Golden Fleece' was the sign of many a hosier's shop in the old City of London. It has been pleasantly said that a probable address of a love letter might have assumed some such form as this, 'This for ye fair Dame Matilda, at ye Golden Fleece, over against ye Roaring Lion and Seven Crowns, nigh unto ye conduit in Chepe.' "

Thus it appears that ever since people first began to live in communities some effort has been made to distinguish individual streets and houses by the use of descriptive or characteristic names which seemed best to fit a particular person, family, merchant, or locality.

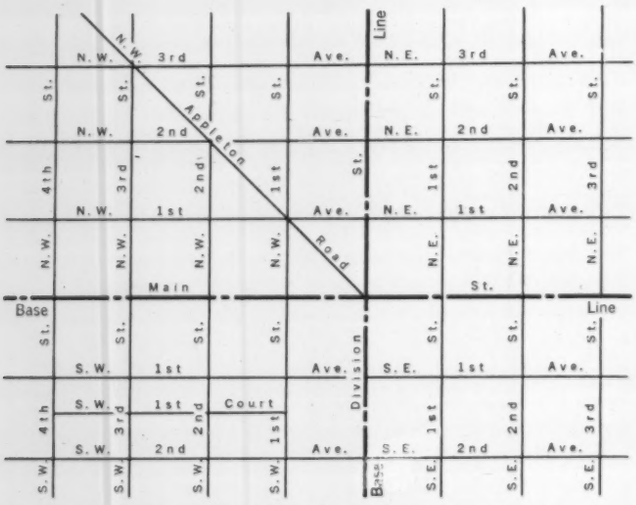

FIG. 1. CITY DIVIDED INTO QUADRANTS; ALL STREETS NUMBERED
Avenues Extend East and West, Streets North and South

Unfortunately, this haphazard method of selecting names, and the lack of centralized authority to pass upon those selected, has resulted in most cities in a sort of hodgepodge system, in which there are often duplications in names and several designations for parts of the same street.

With the passing of time, house numbers were devised to distinguish one house from another. Unfortunately, each community selected its own system of numbering and with the growth, expansion, and consolidation of communities, the result in the larger cities was a mixture of systems, each independent of the other.

The use of house numbers by the postal, police, and fire departments, by public utilities, merchants, taxicab companies, and by the people themselves, plays such a vital part in everyday life that the importance of a uniform system of numbering cannot be over-emphasized. It has been truly said that much time and money are wasted annually by the American public as a result of the unsystematic naming of streets and complicated numbering of buildings. It is also true that a good system of numbering, easy to comprehend, is a large factor in a city's social and commercial life.

NUMBERING HOUSES

A survey of the uniform systems of numbering in the larger cities discloses that the most common is the so-called block system, in which one hundred numbers are available for each block, the odd numbers on one side and the even on the other, one number being assigned to each unit of frontage. Under this system a new hundred is begun at each intersecting street, except where long blocks are adjacent to short blocks, where streets are not continuous, and where diagonal streets break up the usual rectangular layout. At such points adjustments are made to obtain the desired uniformity for the city as a whole.

Another plan is to assign the numbers in succession or continuously along the entire street, allotting one number to a definite amount of property frontage. In both plans of numbering, the zero, or the one hundred, is started at the base or reference line, which in some cases is the edge of the city, and in others, a street or river within the city.

Various systems of naming streets are employed. One plan is to number all of them, designating those going in one direction as "avenues" and those at right angles to the avenues as "streets." This method can be used

to advantage where the city limits can be extended in but two directions. It can also be used where topographical conditions make it advisable to divide the city into sec-

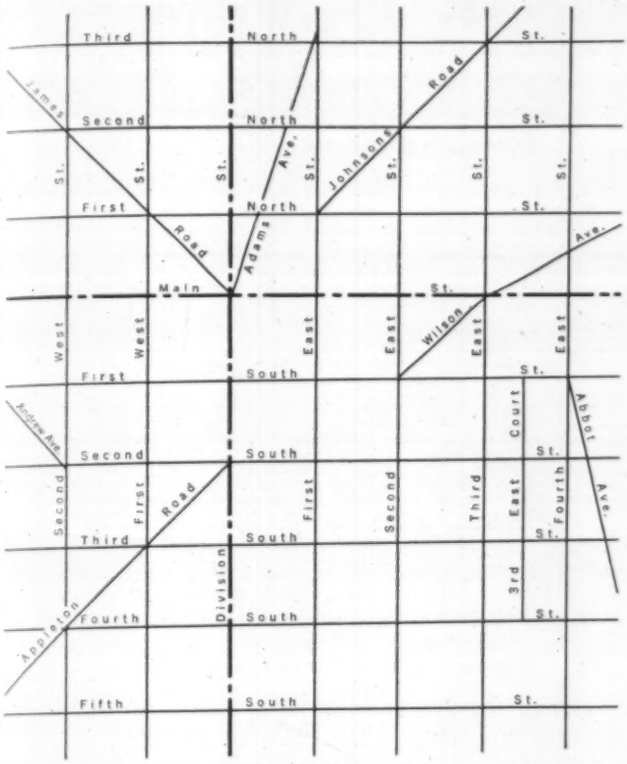

FIG. 2. NO QUADRANT DESIGNATION; ALL STREETS NUMBERED
House Numbers Referred to Two Base Line Streets

tions or quadrants by adding to the street name the prefixes or suffixes, N.E., N.W., S.E., or S.W., to indicate the section or quadrant the street lies in, as shown in Fig. 1.

If such prefixes or suffixes are not used with numbered streets, it becomes necessary to change the nomenclature and use directions with both the street name and the house number to indicate, first, the location of the street with respect to one base line and, second, the location of the house number with respect to the other base line, as seen in Fig. 2. For example, a house number, such as 350 West Sixth North Street, would be found on the sixth street north of the east and west base line and in the block starting with No. 300 west of the north and south base line. The system used in Salt Lake City on certain streets is similar to this.

Another suggested method of naming streets requires the use of numbers for all streets together with eight distinctive names, such as Cedar, Capitol, Birch, Baker, Alder, Alki, Locust, and Lawton to designate the quadrant. Cedar and Capitol are used in one quadrant and similarly two names are used for each of the other quadrants, as seen in Fig. 3. The terms "street" and "avenue" are not used. This method can be extended by the use of more names if the topography of the city, because of rivers or valleys, makes more sections desirable.

In many of our cities, systems have been adopted which combine the use of both names and numbers. In some cases the streets are numbered in only one direction from the base line for the full length of the city and all other streets are named. This is similar to the Milwaukee plan, illustrated in Fig. 4. In other cases the streets are numbered in two directions, those on one side of one of the base lines being called "avenues" and those on one side of the other base line being called "streets." All other streets are given names.

Another system of naming streets is the alphabetical, in which the letters of the alphabet are used in order for the streets running in one direction, and numbers are used for those going in the other.

Still another method is to combine numbered and named streets, using for the named streets an alphabetical group arrangement in which several names beginning with the letter A are used nearest the base line; several beginning with the letter B, next in order; then several beginning with the letter C, and so on.

A rather unique plan, shown in Fig. 5, has been suggested. This allows for four quadrants, in which no directional prefix or suffix is necessary. The thoroughfares parallel to one base line are called streets, and those parallel to the other base line, avenues. The avenues on the west side of the avenue base line are given odd numbers and those on the east of it even numbers, those nearest the base line having the lowest numbers. In the same way the streets north of the street base line are designated by odd numbers and those on the south of it, by even.

FIG. 3. A COMBINATION OF NUMBERS WITH NAMES FOR DESIGNATING STREETS
House Numbers Consecutive North and South from Base Line, and East and West from Meridian; 100 Numbers to the Block

No directional prefixes or suffixes are necessary because the first digit of the house numbers indicates the direction from the base line. Thus 650 First Street would be north of the base line running east and west, because odd-

numbered streets lie north of the base line. Also it is east of the avenue base line, which is evident from the fact that the house number begins with an even digit and therefore lies between the even avenues, which are east of the base line. Similarly, 550 First Street would lie a similar distance west of the north and south base line.

At first glance this plan appears to have some merit. However, a stranger and even the average resident would find it difficult. A person looking for a house number with the impression it was, say 1600, might find that he was mistaken and that 1700 was correct, in which case he would have to travel to the other side of the city.

FACTORS DETERMINING A UNIFORM SYSTEM

The primary purpose of a uniform system of house numbering and street naming is to enable people to find house numbers readily. Therefore the best system for any particular city is that which will offer the least opportunity for misunderstanding and confusion, particularly to those who make use of house numbers most frequently. Uniformity of numbering is by far the most important factor and can be used irrespective of the location of the base lines.

I consider a base line as an "engineering base line," from which measurements are taken to assign numbers to houses. However, from the standpoint of the person looking for a number, a base line has less significance, for he finds his objective without actually starting at the base. He need only know its approximate location in order to decide in which quadrant of the city his number is, and in the last analysis he is guided by the house numbers themselves. Therefore the base line need not be a street or even a series of connecting streets. It can be some imaginary line in a stream, valley, or lake.

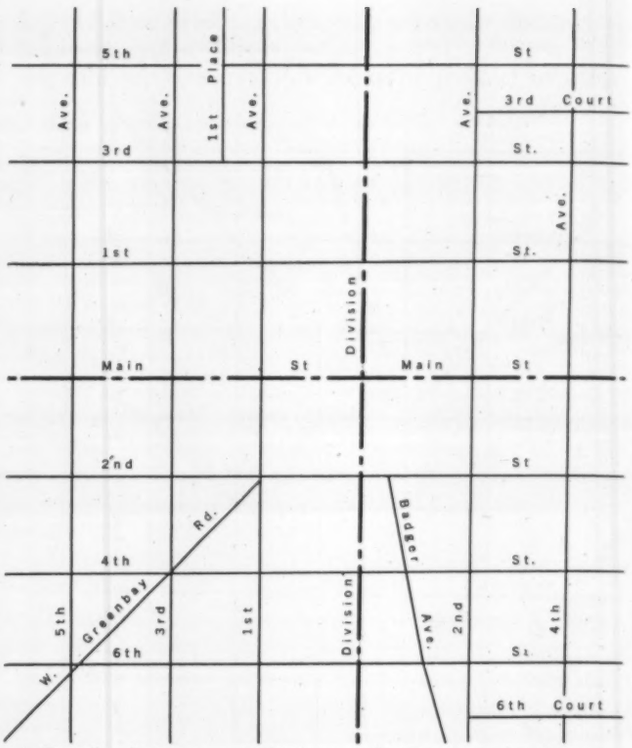

FIG. 5. SYSTEM WITH NUMBERED STREETS AND AVENUES
Odd Numbered Streets North and West of Base Lines, Even Numbered Avenues East and South of Them

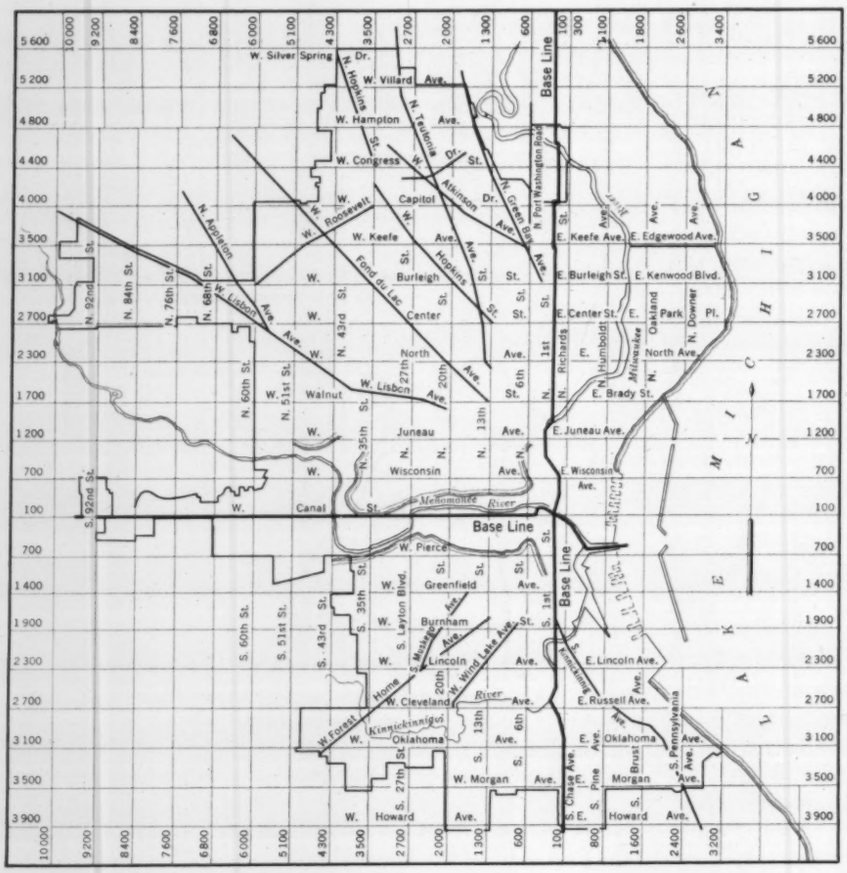

FIG. 4. STREET NAMING AND HOUSE NUMBERING SYSTEM, MILWAUKEE
Selected Base Line a Natural Division of the City

Base lines or reference lines dividing the city into sections may be useful in simplifying the system as a whole and in making it easy to find numbers, or they may unnecessarily complicate the problem. In the selection of base lines, the natural topographical divisions of a city, if there are any, should be recognized and the plan so laid out that certain street numbers will be associated with these natural divisions. A typical illustration of this is found in the City of Milwaukee, where a river valley, varying in width from one quarter to three-quarters of a mile, and running approximately east and west, divides the city into sections which have always been known as the north and south sides of the city.

When the matter of base lines was considered by a commission in 1913, and again by another commission in 1922, Wisconsin Avenue—about seven blocks north of, and parallel to, this valley—was selected as the east and west base line because it was the main street and could easily be found. The Common Council later became convinced that it would be a mistake

to place south streets and south numbers on the north side of the valley, in a section logically called the north side.

It is universally recognized that duplications in street

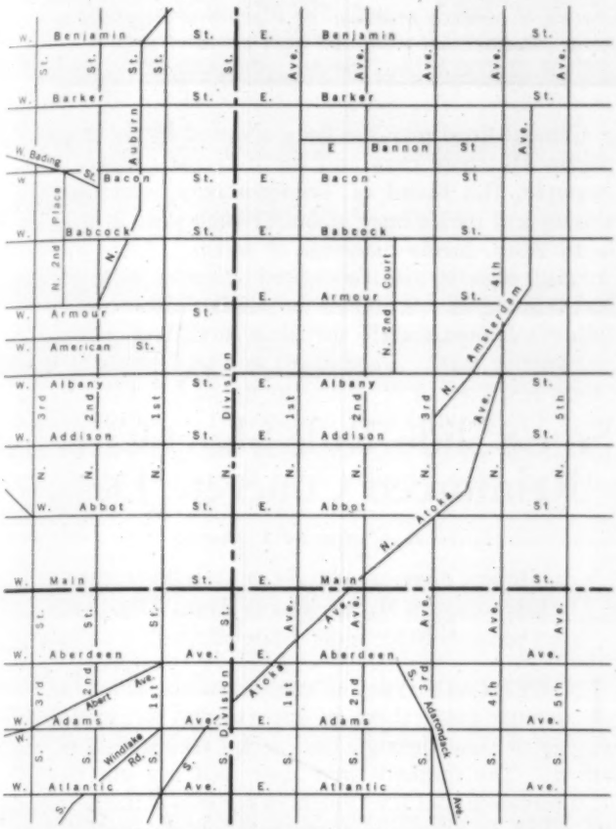

FIG. 6. RECOMMENDED UNIVERSAL PLAN
Numbered Streets and Avenues with Named Streets in Alphabetical Sequence

names should be avoided, and also similar sounding names as far as possible.

Then there is the question as to where the line should be drawn in the use of numbered streets. Will an extensive use of numbered streets in a large city lead to misunderstanding and confusion in the minds of those who make most frequent use of the street designations? This question should receive careful consideration and study. Named streets offer little or no opportunity for misunderstanding, but it is true that for the average citizen or stranger they are more difficult to find than numbered streets.

PREFIXES PREFERABLE TO SUFFIXES

The singular prefixes or suffixes used with a street name are also important, and in the majority of systems in this country one or the other is required. They denote the direction of the street from its starting point at, or some distance from, the base line. In some systems of street naming, plural prefixes or suffixes are used merely in order to determine the quadrant or section in which a certain street lies, and not the direction of the street with relation to the base line. However, the use of plural prefixes or suffixes with the thoroughfares called "streets" in one direction, and "avenues" in the other, designates both direction and general location.

It is the consensus of opinion in the Postal Department that the use of a prefix is very desirable and decidedly preferable to that of a suffix. The department makes every possible effort to secure the adoption of prefixes, claiming that they are considered a part of the street names, whereas suffixes are more readily dropped or forgotten by the general public. The elimination of the suffix or prefix in an address not only causes considerable delay but may result in a monetary loss as well.

SPACING OF HOUSE NUMBERS

Although there appears to be no difference in opinion as to the advantages of the block system of numbering, there does seem to be some disagreement regarding the proper spacing of house numbers. In most cities the frontage allotted to each number is from 20 to 25 ft. In several cities units between 10 and 20 ft. are used. Some use one unit on the business streets and another on the residence streets. It may be found, as was the case in Milwaukee when the change from a 20-ft. to a 15-ft. unit was made, that a certain spacing will reduce the number of fractional house numbers to a minimum, a desirable aim in the business district.

When the situation in Milwaukee was studied, consideration was also given to the decimal system of spacing, by which the block, or the distance to which one hundred numbers are assigned, is divided into 50 equal spaces regardless of its length, and one number is allotted to each space. Thus a number ending in fifty would always be at the middle of the block except where streets are not continuous. The city of Milwaukee saw fit to adopt a system using an interval of one number for each 15 ft. of property frontage. In a few instances, because of the length of the block, the decimal system is used.

SUGGESTED PLAN

Recognizing the fact that numbered streets are the easiest to find, and yet believing that an extensive use of numbered streets in a large city may offer too many opportunities for misunderstanding and confusion to those who must make use of them often, I offer a plan, shown in Fig. 6, in which numbered streets and named streets are combined.

Short diagonal thoroughfares are given names belonging to the group in which the point on them nearest the base line lies, and are called "streets" or "avenues" depending upon their direction and quadrant location. Thoroughfares extending diagonally across and out of the city are called "roads." Perhaps this plan is as near being universally applicable as any that can be worked out, but obviously there are many places where it cannot be used.

No community can afford not to have a systematic plan of uniform house numbering and street naming. The real loss is not in the money spent in making and carrying out such a plan but in the needless expense resulting from the confusion caused by an unsystematic plan. To study this problem, to work out a suitable plan, and to overcome the personal and selfish prejudices of those who object to any and all changes, is worthy of anyone's best efforts. The results of such work will return to the city in tangible and intangible values many times the cost and slight inconvenience involved in putting the plan into operation.

HINTS THAT HELP

Today's Expedient—Tomorrow's Rule

The minutiae of everyday experience comprise a store of knowledge upon which we depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from young and old alike, should afford general pleasure not unmixed with profit.

Cement Lined Cast-Iron Pipe Coated with Bitumen

By W. W. BRUSH

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CHIEF ENGINEER, DEPARTMENT OF WATER SUPPLY, GAS AND ELECTRICITY, NEW YORK

ALTHOUGH the process of lining pipe with cement was introduced by Jonathan Ball in 1843, for 25 years little use was made of it. It is only during the last two years that the Department of Water Supply, Gas and Electricity of New York City has been using cast-iron water pipe lined with cement mortar. The specifications under which the pipe is furnished require that in straight pipes the mortar be applied centrifugally, but in special fittings it may be put on by hand.

The mortar used is mixed approximately in the proportions of from two to three parts of portland cement with one part of sand, all of which must pass a screen having 12 meshes to the inch. The cast-iron pipe is thoroughly cleaned and the mortar is applied while the pipe is being revolved at such a speed that a firm bond is obtained between the concrete and the interior of the pipe. The average thickness of the resulting lining is between one-eighth and one-quarter inch.

Concrete-lined pipe has been used for a number of years in this country. In New England it was employed for water works as early as 1874. The innovation in New York consists in coating the cement with tar or asphalt, a method used in England for a number of years but not previously in this country, it is believed.

The object of the tar or asphalt coating was to reduce the hardening of the water when the mains were first laid and when the draft would in general be so slight that the water would become hard through taking up the soluble portion of the cement while slowly passing through the pipe. Laboratory experiments with cement-lined pipe coated with tar show that this aim is satisfactorily accomplished. It was also hoped that the tar coating would increase the effective life of the cement by reducing the rate at which the soluble portion of it is taken up by the water. This purpose may or may not be accomplished.

As was expected, difficulty was experienced in satisfactorily heating and dipping the pipe, because of the effect of such heating in weakening the bond between the cement lining and the cast iron. We have therefore modified our specifications to permit the cement lining to be sprayed with a cold asphalt paint of a brand approved by the department, and the exterior of the pipe to be coated either by spraying or brushing. The increase in the cost of the pipe due to the addition of the cement lining, including the coating, is estimated at approximately $5 per ton.

Cement-lined pipe has been adopted by other city departments than ours and for different purposes. For example, the Board of Transportation specifies it for sewers and uses a large quantity each year in sizes from 6- to 24-in. inside diameter of metal.

Steel pipe is also fabricated commercially with cement lining of $^1/_8$ to $^3/_{16}$ in. thick. The cost of this lining is approximately the same as that of galvanizing.

Some Slide-Rule Short Cuts for Reinforced Concrete Design

By CHESLEY J. POSEY

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INSTRUCTOR IN MECHANICS AND HYDRAULICS, STATE UNIVERSITY OF IOWA, IOWA CITY

IN CERTAIN types of computations which are frequently made there is opportunity for considerable saving of time through the careful elimination of waste effort. The methods here described are not new, but it is probable that few designers know how much time can be saved by means of a few such simple short cuts and by carefully planned use of the slide rule. In the design of a single beam, it would hardly be practicable to give much thought to the best form for the computation, but in the design of a thousand or more it becomes exceedingly worth while to devise methods for doing the work as quickly as possible. The structural designer who must turn out reinforced concrete designs rapidly finds it important to simplify the computations for beams and slabs.

Many have discarded the charts and tables commonly used for this work, finding that it can be done more quickly with the slide rule alone. The tables of areas and perimeters and the charts of coefficients are replaced by a few notations on the scale and some temporary marks made with a glass writing pencil on the runner. This article presents a number of short cuts that have been found most useful, and will, it is hoped, suggest similar short cuts for other problems. The notation used is that of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete, as found in its report in PROCEEDINGS for October 1924.

Usually, on a given job, the same working stresses and value of n will be used throughout. Compute the value of K corresponding to balanced reinforcement at these specified stresses. Set the hair line of the glass runner at $\frac{12}{K}$ on the A scale; then make a mark on the glass directly over 1 on this scale. If this mark be set above a bending moment, M, expressed in foot-pounds, the hair line will be at $M \times \frac{12}{K}$ (both on the A scale).

Now $M \times \frac{12}{K} = bd^2$. If the end of the B scale be set opposite a value of b on the A scale, the corresponding value of d will appear under the hair line on the C scale. For example, consider the following problem.

What proportions may be used for a beam resisting a moment of 25,000 ft-lb., using $f_s = 16{,}000$, $f_c = 650$, and $n = 15$?

$$k = \frac{nf_c}{f_s + nf_c} = 0.38,\ K = {}^1/_2 f_c jk = 108,$$

$$j = 1 - \frac{k}{3} = 0.873, \text{ and } \frac{12}{K} = 0.111$$

For just one computation it is not worth while to mark the runner, so multiply $M = 25{,}000$ (on the left half of the A scale) by 0.111 with the B scale, and leave the runner at about 2,800 on the A scale. Now setting the left end of the B scale opposite $b = 12$ in. on the A scale, read $d = 15.3$ in. on the C scale. Similarly, when $b = 10$ in., $d = 16.8$ in., and when $b = 14$ in., $d = 14.2$ in. Choice will depend upon shear or bond, room for bars, or other considerations.

TENSILE STEEL

Make two marks on the glass runner above the C and D scales at a distance apart equal to that from 1 to $\frac{jf_s}{12}$ on the D scale. This will permit dividing the moment by both $\frac{jf_s}{12}$ and d with one setting of the slide, leaving 1 on the C scale opposite A_s on the D scale. Then the number of bars required of any size will be found on the CI scale opposite the area of that size on the D scale. If bar spacing for a slab is desired, divide A_s by 12, leaving the end of the C scale opposite $\frac{A_s}{12}$. Bar spacings are now found on the C scale opposite areas on the D scale. Since in both cases the areas appear on the D scale, it is convenient to have the areas of the standard bar sizes marked by small dots just below the D scale. For example:

$M = 25{,}000$ ft-lb., $b = 12$ in., $d = 15^1/_2$ in., and $A_s = 1.38$ sq. in., requiring either four $^3/_4$-in. round bars, three $^7/_8$-in., round bars, or two 1-in. round bars. If a slab, it would be necessary to provide $^3/_4$-in. round bars at $3^3/_4$-in. spaces; $^7/_8$-in. round bars at $5^1/_4$-in. spaces; or 1-in. round bars at $6^3/_4$-in. spaces.

The formulas for unit shear and for unit bond,

$$v = \frac{V}{bjd} \text{ and } u = \frac{V}{\Sigma ojd}$$

can be written

$$v = \frac{V}{jd} \times \frac{1}{b} \text{ and } u = \frac{V}{jd} \times 2.55 \times \frac{1}{Nn}$$

where N = number of bars, and n = number of eighths of an inch in the diameter of the bar. Divide V by jd so that the result is on the D scale under the runner. Divide by b and obtain v without disturbing the runner. Then set 2.55 on the CI scale under the runner. Values of u are then found on the D scale opposite values of Nn on the CI scale. Multiply Nn mentally.

For example, suppose that $V = 10{,}000$, $b = 12$ in., and $d = 15^1/_2$ in. Using $j = 7/8$, $v = 61.5$ lb. per sq. in. With four $^3/_4$-in. round bars, $u = 78^1/_2$ lb. per sq. in.; with three $^7/_8$-in. round bars, $u = 90$ lb. per sq. in.; and with two 1-in. round bars, $u = 118$ lb. per sq. in.

To check the steel and concrete stresses in a beam already designed, it is necessary to locate the neutral axis. For a rectangular beam without compressive steel, use the relation $\frac{k^2}{1-k} = 2pn$.

Set 1 on the B scale opposite $2pn$ on the A scale. Find a reading on the D scale opposite a reading on the left half of the B scale such that the two add up to 1.000. This may be done quickly if the B scale is read backwards, 9 as 1, 8 as 2, 7 as 3, etc. The reading on the D scale is the desired value of k. To find $j = 1 - \frac{k}{3}$, divide k by 3 and read the result backwards on the D scale.

For example, assume that $p = 1$ per cent, and $n = 15$. Setting the rule as described, we find $k = 0.419$, and $j = 0.861$.

If stirrups are necessary, the following method gives results that are always on the safe side, and while it may require a few more stirrups, enough time will usually be saved in the office to pay for the extra material. Assume that we have an 11 by 22-in. (net) beam on a 20-ft. span, carrying a total uniform load of 2,200 lb. per sq. ft. The end shear is 22,000 lb., and as one-fourth of that amount must be provided for at the center, the decrease is 1,650 lb. per ft. The stirrups should be spaced so that:

$$\text{stirrup spacing} = \frac{jd \times (\text{allowable total stress on one stirrup})}{(\text{shear to be carried by stirrups})}$$

The product of jd and the allowable total stress on one stirrup is a constant as long as the depth is constant and only one kind of stirrup is used. If $^3/_8$-in. round-bar U-stirrups are used in the example, this quantity is $^7/_8 \times 22 \times 0.22 \times 16{,}000 = 67{,}800$.

If the end of the C scale be set above this constant, the stirrup spacing required will be found on the D scale under the shear to be carried, as read on the CI scale. The computations for spacing take the following form, which is self-explanatory:

Total shear at end = 22,000 lb.

Total shear carried by the concrete,

at 50 lb. per sq. in. $= \frac{10{,}600}{11{,}400}$, requires 6-in. spacing, use 1 at 3 in.

$3 \times \frac{1{,}650}{12} = \frac{410}{10{,}990}$, requires 6-in. spacing, use 3 at 6 in.

$18 \times \frac{1{,}650}{12} = \frac{2{,}475}{8{,}515}$, requires 8-in. spacing, use 2 at 8 in.

$16 \times \frac{1{,}650}{12} = \frac{2{,}200}{6{,}315}$, requires 11-in. spacing.

Since 11 in. is the maximum spacing allowable, use 11-in. spaces for the remainder of the distance over which stirrups are required. The number required will be

$$6{,}315 \div \left(11 \times \frac{1{,}650}{12}\right) = 4.2, \text{ use } 4.$$

OUR READERS SAY

In comment on Papers, Society Affairs, and Related Professional Interests

Trench Method of Building Subaqueous Tunnels

DEAR SIR: The article by F. H. Frankland, entitled "Tunnels or Bridges—Which?" in the February issue, contains some statements relative to tunnels which should not go unchallenged. However, in the limited space available, comment can be made on the salient features only.

The facilities of the bridge which permit 26 single trackways—of which 16 are vehicular, 4 railroad, and 6 rapid transit—are given as a standard of comparison which must be met by estimates for building an equal number of tunnels, totaling 26 trackways, whose cost is given at $531,000,000, against a cost of $150,000,000 for the bridge. It is pertinent to ask if there is any reason for concentrating the terminals of all these facilities in one area, other than the fact that the width necessary to accommodate them is required to give lateral stability to the bridge. In the matter of estimate, the Holland Tunnel cost, for the 7,000 ft. of river section, about $2,800 per ft. contract price, or $700 per track ft. Mason and Hanger have a contract with the Boston Transit Commission for constructing a tunnel for something under $650 per track ft. as shown by the bid figures. The construction of this tunnel, which is larger than the Holland Tunnel, is progressing satisfactorily. The cost of work on this project is a fairly good check on present prices and conditions. Therefore, if we add 20 per cent to the Holland Tunnel contract price and 50 per cent for all other charges, we arrive at a price of $50,000,000 for each of four tunnels, each of a length about equal to that of the Holland Tube.

As to the four railroad tunnels and the six rapid transit tunnels, it can probably be shown that their cost would not exceed from 40 to 45 per cent of the estimate given by Mr. Frankland. The cost of building such structures, particularly when they can be of flat steel design, as are shown in Figs. 1 and 2, and do not require air duct ways, is small in comparison with that of constructing vehicular tubes. This brings a fair estimate of the cost of facilities equaling those provided by the bridge to about $280,000,000, instead of $553,000,000. To insure a fair comparison of costs of these structures, there must be added to the cost of the bridge an estimate for building the terminals, which, in the case of a bridge of this size, would materially increase its cost.

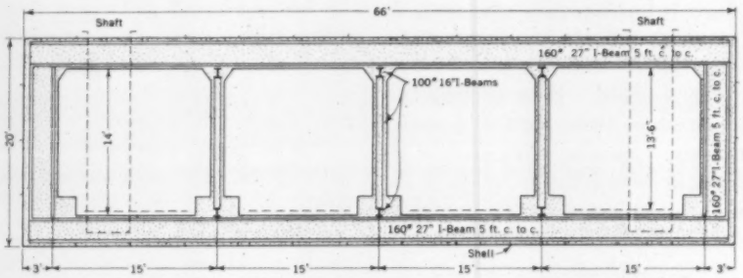

FIG. 1. SUGGESTED FOUR-TRACK SUBAQUEOUS RAILROAD TUNNEL
Displacement and Weight of Each 250-Ft. Section About 41 Tons per Ft.

In making estimates for comparative costs, each estimate should be as fair as possible. For instance, in comparing bids for the Philadelphia-Camden crossing, the tunnel estimates varied from $12,700,000 to $14,200,000, while the estimate for the bridge was $11,100,000. Taking into account some added facilities Mr. Frankland gives the cost as $37,000,000 for the bridge, as completed in 1926. Comparative estimates should include not only operating expenses in each case but also the capitalized value derived from building facilities where and as required. In such cases the balance will almost uniformly rest in favor of the tunnel.

On page 89, Mr. Frankland makes the unfortunate statement that, "the trench method for construction of the tunnels was considered impracticable." In view of the successful completion of the Harlem River, the Alameda, and the two Detroit River tunnels, as well as one under the Gowanus Canal in Brooklyn, and in further view of the recent development of this art, such a statment does not appear warranted by fact. There may be locations where it is inexpedient or uneconomical to build the trench tunnel, but I believe it can be definitely shown that there are very few places, if any, where this is the case.

Typical sections of tunnels I have designed to be built in trenches are shown in Figs. 1 and 2. Both are of the flat steel type—one, Fig. 1, for a four-track railroad tunnel; the other, Fig. 2, for a four-lane vehicular tunnel. The latter has divided lanes of traffic, except for 25-ft. crossovers every 250 ft. These sections are best adapted to be built by methods designed by the writer. The advantages over round sections are a saving in depth-dredging and gradient, and greater simplicity and economy of construction.

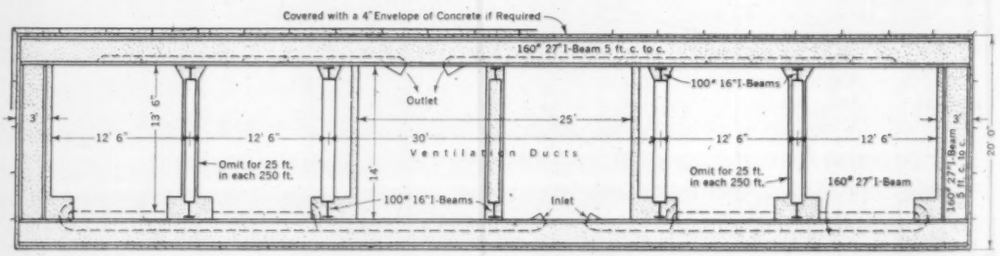

FIG. 2. PROPOSED FOUR-LANE SUBAQUEOUS VEHICULAR TUNNEL
250-Ft. Section, Weighing 54 Tons per Ft., Provides a Crossover

J. C. MEEM, M. Am. Soc. C.E.
Consulting Engineer

Brooklyn, N.Y.
February 4, 1932

Need for Care in Resurveying

TO THE EDITOR: I should like to make a few comments suggested by Professor Dodds' article in the December issue.

The definitions of the U.S. Land Office for the obliterated corner and the lost corner are confusing. It bothers the novice to distinguish between the two and to know why they are so called. It should be remembered that the term "obliterated" refers to the material or object with which the corner was marked. If the stake is gone, the mark obliterated, the corner is said to be obliterated. The word "lost" as applied to corners means that their original position cannot be determined, and that there is not enough evidence as to where the corner originally was placed to convince the jury if the case should come to trial. The surveyor constantly must ask himself, "What evidence have I to convince a jury of the correctness of my procedure?"

In surveying to reset an obliterated quarter corner between two sections, the easy and obvious thing to do is to call the corner a "lost corner" and to run a straight line between the section corners to the north and to the south, and reset the corner halfway between or at proportional distances and on line. Suppose, however, that some years before this time a surveyor had subdivided the southeast quarter of the section to the east of this quarter corner and that a stake or monument marking the center corner of the four "forties" of the quarter section is found.

By working back from this stake the east and west quarter line can be projected westward and the location in latitude of the missing quarter corner can be found. A relocation of the missing quarter corner at the intersection of this line and a line connecting the two section corners will be in agreement with the old stake which was placed at the time the original quarter corner was in existence.

The surveyor must not ignore any information that he may find in the sections adjacent to the one being surveyed. If the quarter corner discussed above were restored as a lost corner, it would probably fail to agree with the 40 corner set in the southeast quarter years before by the surveyor when the original quarter section corner could still be found.

RAY S. OWEN
Chairman, Department of Topographic Engineering, University of Wisconsin

Madison, Wis.
December 29, 1931

Increased Consumption a Vital Factor

DEAR SIR: Mr. Grunsky's paper, "The Way to National Progress and Prosperity," in the October issue, has given an impression which was probably not intended —namely, that the basis of taxation can be decided on moral grounds. The endless tariff argument ought to make clear the fact that right and wrong, as applied to fiscal policy, are merely emotional names for "my side" and "your side." The tariff is a device for making consumption less and production more; the income tax is the opposite; there is no clear moral ground for choosing either.

The essential question is not a moral but a mathematical one. Since we turned into a creditor nation, is it not true that we can no longer sell a net surplus abroad? Since the increase of population started to slack off, can we escape the fact that further growth of business must depend on expansion of the average consumer income? Is it not true that the development of resources and of equipment has already outrun the growth of the consuming market? Is it not a mathematical necessity that the free accumulation of great wealth must lead ultimately to over-equipment and paralysis? Has not that result already occurred in this country?

The reason the traditional judgments of the Fathers are no longer in line with the needs of the country is quite simply that the country is no longer under-equipped, deep in foreign debts, and growing like a prairie fire. What the country needs now is a means of limiting the growth of useless machinery and expanding the consumption of goods. The nature of the facts will insure that we shall suffer recurring paralysis until we stop thinking in terms of conditions which have ceased to exist; and it ought to be the engineers who help to shorten the period of discipline.

When we are ready to tax with the purpose of limiting the accumulation of unspent wealth, we shall have more spending; and, immoral as it may sound to our frugal ancestors, in a "plenty" economy more spending means more business.

DAVID CUSHMAN COYLE, M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.
February 1, 1932

Present Burden of Taxation Too Heavy

DEAR SIR: Under the interest-compelling title, "The Way to National Progress and Prosperity," in the October issue of CIVIL ENGINEERING, C. E. Grunsky repeats with variations the oft-heard suggestion that to mitigate recurrent business depressions, the Government should collect and spend increased sums of money. Although exception might well be taken to his view of the underlying cause of unemployment, I seek here rather to dispute his suggestion that if the burden of taxation "were distributed commensurately with the ability to pay, there would be less dissatisfaction," notwithstanding the increased collection.

It is curious, not to say perplexing, that engineers, who are trained above most others to apply fundamental principles to the solution of their problems, should avoid that method when they think about taxation. Said Mr. Grunsky, "The tax on real estate should be just enough to prevent the land from lying idle too long." Must we believe that he thinks a tax on buildings will force land into use? Yet he said "real estate," and buildings are real estate.

Taxes are money taken from people on diverse pretexts for a specific purpose. Since we are here concerned with the distribution of the burden of taxation, we are not interested just now in the purpose of it. Taxes are money taken from people on pretexts; and the pretexts used are many. If a person receives an income, if he creates or otherwise acquires property, if he conducts a business—and simply because he has done these things—money is taken from him. The effect of taking money from people because they have done certain things is well known, especially to the criminal courts. Well do legislators of customs tariffs know that the effect is just the same whether a court or a tax collector takes the money, and whether the thing done be evil or good; the would-be doer is deterred.

Substantial amounts are taken in the name of taxation, and severe are the burdens laid upon those who create wealth and conduct business. A 2 per cent annual tax upon the value of a building, capitalized at 5 per cent, is equivalent to a 40 per cent ad valorem duty collected once. I hold that the burden upon business of the general property tax, and of other similarly burdensome taxes, is extremely severe, and also unnecessary.

At this point, the clew so happily given by Mr. Grunsky is most useful. The tax on land (not real estate) should be just enough to prevent land from lying idle too long. Note that land can be valuable only if it is wanted for present use, unless scarcity caused by speculation has given it a value based on prospects of future use. Note also that no person has ever created land and therefore that no person can be deterred from creating it by taking money from him. The value of the land a person holds is not his creation either. I maintain that valuable land should not be held idle at all unless there is good reason for it, and that speculative gain is not a good reason. I suggest that the entire annual (rental) value of a piece of land is an amount just enough for the municipality to take by taxation to prevent the land from being held idle too long. If each year's tax amounts substantially to the annual value of the land, only with very good reason will a person be able long to hold valuable land idle. Then it will not be necessary for cities, states, and other taxing authorities to take money from people on pretexts that deter them from undertaking and carrying on business. In other words, the entire list of taxes burdensome to people in the conduct of their business can be abolished.

Will business be likely to prosper with its tax burden lifted? Will it welcome access to valuable land on easier terms? I venture to assert that, as a result of the courageous application of the fundamental principle I have here pointed out, business would emerge permanently from a state of chronic depression, of which the current slump is but an acute manifestation.

JOHN R. NICHOLS, M. Am. Soc. C.E.
Consulting Engineer

Boston, Mass.
January 22, 1932

Details of a Self-Anchored Suspension Bridge

TO THE EDITOR: Various unusual features in the design of suspension bridges have been discussed in connection with Mr. Steinman's article on the St. Johns Bridge in the September issue of CIVIL ENGINEERING. The possibility of the application of the rope strand cable for increased span lengths of self-anchored suspension bridges has been pointed out.

In view of these facts, it may be opportune to call attention to a German bridge of this type—probably the only one of its kind—the Köln-Mülheim bridge over the River Rhine, which was built during the period from 1927 to 1929. The following details concerning this very interesting structure are taken from *Die Bautechnik*, Germany's foremost civil engineering magazine.

The main span has a length of 1,034 ft. from center to center of the towers, and each of the straight backstays measures 298 ft. from the center of the tower to the center of anchorage. The roadway, carrying two car tracks, has a clear width of 68.3 ft. and the two sidewalks, placed outside the stiffening girders, have a clear width of 11.5 ft. each. Transversely the tower columns measure 72.8 ft. from center to center.

Each of the main cables consists of 37 rope strands of the closed type, each rope having a diameter of 3.15 in. and a net area of 6.59 sq. in. The form of the cable is hexagonal, with a maximum diameter of 22 in. Each of the strands was pre-stretched for two hours under a load of 530,000 lb., or about four-tenths of the ultimate strength. Except at the towers and anchorages, where they have been deepened, the stiffening girders are constant in depth. They are of the box type, 19 ft. 8 in. deep back to back of angles, spliced horizontally, each of the four web plates being 9 ft. 10 in. deep.

F. DE SCHAUENSEE, M. Am. Soc. C.E.
Associate Engineer, Waddell and Hardesty

New York, N.Y.
January 11, 1932

Engineers and Present-Day Economics

DEAR SIR: Man craves to be master, not only of nature but also of his own kind. To acquire mastery, force and cunning have built many weapons, but none more effective than accumulated wealth. And wealth demands ugliness. Obviously, this should be the concern of the engineer, for he is the one who, more than anyone else, has planned how to secure the wealth hidden in nature.

Being the most important producer of nature's wealth, has he also received the most abundant share of this wealth and the mastery which goes with such abundance?

Hardly; instead, with a few exceptions, he is a day-laborer only, hired as his thoughts and judgment may be needed, and discharged as the wealth he produces may be coveted by his greedy master. More than any other class of people just now engineers are out of work, walking the streets wearily and begging for a chance to extract some more wealth from nature, so that they themselves—and their families—may live. Twenty per cent of the profession are idle and over fifty per cent are working part time only.

In times like the present it is futile to search for work. The world is sick from too much wealth and to produce more would make things worse and not better. The high leadership has gone mad indeed in its greed for gain, and the political control, built to safeguard against disaster, has surrendered in ignominy. A famous engineer has recommended charity as a solution; sooner or later even the engineer will have to accept this invitation and ask for a few crumbs of the wealth his thoughts and labor have produced.

This humiliating condition is in a sense very well deserved, for the engineer has worked as an engineer pure and simple—sometimes as a financier but not as an economist. In a double sense, engineers have worked overtime to establish maximum efficiency, and in doing so have forgotten that the game has two sides and that one of these is destructive. Only by planning for substantial compensation in social and spiritual values can the economic gains be permitted. Should greed compel more, it will destroy both the social and economic structure and thus, also, every chance for a normal profit.

By inference or directly, high Government officials, leaders of professions, industrialists, and financiers—but particularly so-called financial writers—have stated

that the reasons for our distress are a mystery and that nothing can be done as a cure except to be patient and let natural laws take their course. If we accept this point of view, we are not true Americans. It would mean the surrender of our right to think the problem through and see it through by democratic initiative and resourcefulness. Democracy has been severely interfered with by the power of money, but we are not yet ready to accept the doctrine that money is the master of a man born to freedom.

The theory explaining our economic cycles and depressions is really very simple, and the formulation of an economic plan to prevent depressions is quite feasible. To secure the execution of such a plan either by agreement or legislation is another matter, however. Greed has become not only a habit, but also a very respectable one. In addition it is quite blind and will presumably insist upon following the road that leads to certain chaos rather than accept a scientifically computed profit. Greed will therefore surely veto any plan for economic security and social equity.

There should be no illusion in regard to the battle between money and democracy. Moronity is spreading in response to the needs of the industrial machine, and simultaneously there is a decay in the general sense of honor through the practice of securing and granting extra-legal privileges. It is quite possible therefore that democracy, for the time being slumbering, may sometime become quite dead. Will that which is to follow be a mere accident or will it be thoughtfully planned? Evidently this is particularly a question for every lover of human progress and for every man who is anxious concerning his future.

The present economic situation should therefore be considered as a challenge to all engineers—and to Society officers—not merely to carry on faithfully, but to do a little independent thinking and to express themselves courageously so that the country—and with it the engineering profession—may reach a higher plane.

I. OESTERBLOM, M. Am. Soc. C.E.

Chicago, Ill.
Jan. 17, 1932

Important Factors in Trickling Filter Treatment

DEAR SIR: The article, "Trickling Filter Loadings," by Messrs. Childs and Schroepfer, in the December issue, presents a valuable collection of data upon the efficiency of a number of trickling filters that treat both sewage and industrial wastes. Unfortunately, the striking uniformity of the "percentage removal" of organic matter by the various filters, when operated at different rates of flow, has led to the presentation of the data in graphs where this uniformity has been emphasized. In many cases, however, the final quality, or strength of the effluent, is of major importance. Thus any uniformity in the percentage removal of organic matter would be of little avail were the strength of the influent, and hence that of the effluent, to be high for appreciable periods of time. In fact there are many plants where the effluents must have an average 5-day B.O.D. (bio-chemical oxygen demand) of about 25 p.p.m. (parts per million).

The data presented in the paper indicate that the strength of the influents of even the most efficient of the various trickling filters cannot exceed about 250 p.p.m. to insure such an effluent. Hence, sewage and industrial wastes having strengths exceeding this value must either be applied at unit rates of flow lower than usual, or else the influent must be diluted with water to reduce the 5-day B.O.D. of the mixture to that of average strength sewage. This conclusion is substantiated by various experiments in the treatment of industrial wastes on trickling filters.

It is evident that the effectiveness of trickling filter treatment will be influenced by a number of factors, such as climatic conditions, hydraulic limitations in the distribution of sewage at very low and very high rates of flow, interference with aeration by prolific growth of fungi on filters dosed at high rates of flow, and the "poisoning" of organisms in the filter bed by the accumulation of their products of metabolism when strong wastes or sewage are treated at relatively low rates of flow. Available information seems to indicate that dilution of strong wastes and their application at relatively high rates are preferable to treatment of concentrated wastes at lower unit rates of flow.

Statistical study has indicated that the effectiveness of filtration disinfection and allied phenomena may be easily plotted on logarithmic paper to produce a straight line graph, the basic formula of which is $Y = X^c$. Thus the 5-day B.O.D. of the various influent samples, Y, would be plotted as the ordinate, and the corresponding 5-day B.O.D. of the effluent samples, X, as the abscissa. The exponent c would determine the slope of the straight line, and would represent the performance of a specific filter. The comparison of various values of c for different filters would give a numerical measure of differences in performance. Furthermore, any marked break in the straight line would represent a critical point in the performance of the specific trickling filter, and hence would serve as a guide to limitations of maximum and minimum strengths, or rates of flow, of applied sewage or wastes for given conditions in trickling filters. The grouping of the plotted data along a straight line would indicate that the sampling was representative of actual conditions and that the filter was performing normally. Erratic data, therefore, would indicate an inconsistent performance.

The basic difficulty of such a study as that under discussion is the absence of comprehensive data covering large variations in rates of application and strength of applied sewage. Also, it is difficult to use the same terms of comparison for data collected from various plants when many local variables are influencing factors and modify the character of these data.

CHARLES R. COX, Assoc. M. Am. Soc. C.E.
Assistant Sanitary Engineer, State Department of Health

Albany, N.Y.
January 25, 1932

Engineering-Financing Syndicate Would Be Welcomed

TO THE EDITOR: As an engineer familiar with the Latin-American field, where I have been connected with North American engineering enterprises, I take the liberty of offering some comments on the interesting suggestions made by Dr. Waddell in the November number.

It is a well known fact that up to the present time only isolated efforts have been made by a few American engineering and contracting firms to obtain Latin-American engineering business, but no proper coordina-

tion of all these activities, as outlined by Dr. Waddell, has ever been attempted. I believe that an organization of this character would be highly welcomed in Latin America, and it would be advantageous to the engineering profession and to a great many American manufacturers and business men.

Because of prevailing economic conditions and the recent market depression of South American bonds, the financial aspect of the proposed organization is the fundamental consideration. However, the success of an enterprise of this nature would largely depend on the men selected for what I would call the "diplomatic engineering side" of the business and on their ability to gain the confidence of our Latin-American friends; on the careful study of franchises, concessions, or securities that might be offered in connection with any proposed enterprise, for which a thorough knowledge of the locality is essential; and on the establishment of branch offices at some of the Latin-American capitals and the cultivation of close social relations there.

It is a fact that some Latin-American countries prefer to deal with European firms, but I have found that it is not difficult to overcome this feeling when projects are introduced in the right way.

CARLOS DEL VALLE, M. Am. Soc. C.E.
Consulting Engineer

San Juan, Porto Rico
January 24, 1932

Developing Latin-American Resources

TO THE EDITOR: Dr. Waddell's letter on "A Latin-American Engineering and Construction Enterprise," in the November issue, was read with much satisfaction.

Latin America has reached a stage where it undoubtedly needs and probably would welcome, in most instances, the concerted action of a financially powerful organization bent on its development according to a systematic and honest program. The recognized critical state of most national budgets presents a situation not over-encouraging to external capital investments in the form of further loans.

The proposed syndicate would perhaps evolve a distinct basis for enterprise so as to safeguard the amount of capital involved. This would appear necessarily to limit its activities to projects based on charters, grants, or concessions. I agree that the syndicate should be introduced to the various countries with a view to convincing the inhabitants of its highly ethical purposes, thereby eliminating all possible fear of presupposed exploitation. The governments should primarily be made acquainted with the true motives and, above all, their full cooperation should be obtained. Affiliation with local civic organizations would likewise prove an advantage.

Nearly a half century ago, an international group composing the Inter-Continental Railway Commission envisaged the development of Latin America as an entity by the construction of an arterial railway from the United States to the southern extremity of South America. Preliminary surveys were completed, but no attempt was made to finance the project as a whole. In that day of pioneering railroads, the principle of continuous railway transportation was the fundamental stepping-stone to international development and commerce. The scheme, however, was not carried through, presumably because the embryonic state of a large proportion of the territory traversed failed to justify the necessary expenditure when balanced against probable returns.

With the advent of vehicular motor travel and transport, railway extensions have become much less applicable to new countries than ever, and highway construction is the recognized medium of the day.

That there is a sad need for adequate means of intercommunication in much of Latin America cannot be denied. Numerous projects for the development of a great diversity of natural resources have been hindered, if not completely prevented, for no other fundamental reason.

The establishment of a syndicate as outlined would constitute a movement of real constructiveness and consequence. It would appear that, after analysis of the whole Latin-American field, its first efforts should be directed toward the furtherance of essential improvements, preferably international in scope and of vital importance to the promotion of industrial and commercial interrelations. Social and political rapprochement would inevitably follow.

The surplus of inactive funds in our country, and the great need for new fields of exchange and consumption indicate that the present is not only the opportune time for Dr. Waddell's plan but that it demands exactly such steps as his plan anticipates.

M. J. BUSSARD, Assoc. M. Am. Soc. C.E.

Washington, D.C.
January 28, 1932

Greater Understanding First Prerequisite

DEAR SIR: I have read with considerable interest the letter by Dr. Waddell in the November issue of CIVIL ENGINEERING. Having spent four years—from 1912 to 1916—in South America on a large construction project, and having visited most of the larger countries on the continent, I have some knowledge of conditions and a keen interest in developments there.

To speak in generalities is somewhat dangerous, as conditions vary greatly in the different countries. On the other hand, considering Latin America as a whole, I have been discouraged and disconcerted, as a loyal American, to see how ill equipped we have shown ourselves to expand into that field. South America is really the only continent where we should have more than an equal opportunity to compete with engineers and financiers of the world.

The possibilities under normal conditions are very extensive. The North American type of engineering executive is actually greatly needed. Just as we furnished men with enough initiative to build a Panama Canal, so should we be able to pioneer in other lines in these essentially undeveloped countries.

We are almost wholly lacking in the necessary contacts and understanding of fundamental conditions, and entirely too provincial in our outlook at home with regard to such matters. And yet our country is in by far the most favored position financially and politically to undertake such work. Again, there could be no better time than during the present depression, and before another period of prosperity distracts attention, to

investigate and be prepared to carry forward some really progressive undertakings.

I believe that engineers of the requisite ability can be found; whether they will be of sufficient understanding of Latin-American character and conditions, I am not so sure. Certainly very few contractors in this country have the proved skill and efficiency to handle work under these conditions. Others might acquire the necessary characteristics, but at considerable expense to their financial backers. Many of our countrymen have proved anything but adaptable under such circumstances.

As to employing lecturers to appear before civic bodies, there are almost no such bodies to be found. How many cities are there in which it would be worth while to appear? Hardly a dozen.

South America is composed of a comparatively small educated and ruling class, and a great percentage of the laboring or peon population. Any proposition must be sold to the former concentrated group only, and through personal or very small group contacts. It is basically entirely different from comparable work in the United States.

This does not mean that I disapprove of Dr. Waddell's idea in essence. Indeed, I believe that it contains the first elements of a really progressive undertaking in Latin America, and that some such method is the only one that offers any real hope of success in meeting the competition of our European rivals.

HOWARD E. BOARDMAN, M. Am. Soc. C.E.
Dudley Professor of Railroad Engineering
Department of Civil Engineering
Yale University

New Haven, Conn.
January 6, 1932

Tact Needed in Latin America

DEAR SIR: The proposal by Dr. Waddell, in the November issue, seems to be a very ambitious one and worthy of full consideration. The Latin-American countries have great undeveloped resources and opportunities. In the past, they have not at all times received our advances with cordiality and the matter would have to be very carefully handled by the proposed syndicate; nor have they accepted our capital for development. They prefer to develop their countries themselves but have not the resources to do this. We have done considerable work in Mexico, where one effective slogan is "Mexico for the Mexicans."

This syndicate would be largely dependent upon financiers. The engineers would be the first in the field to study the local situation and determine the feasibility and financial possibilities of a proposition. It would be their duty to decide whether the proposition would be a paying one or not and to make recommendations to the bankers, who would then of course make their own financial investigation.

There are many profitable enterprises awaiting development if we could get in touch with them in such a manner as to be welcomed by the countries in which they are located. Such an arrangement, as Dr. Waddell says, should be advantageous to all concerned and is worth further consideration.

E. H. CONNOR, M. Am. Soc. C.E.
Chief Engineer, the Missouri Valley Bridge and Iron Company

Leavenworth, Kans.
January 4, 1932

Engineering-Financing Syndicate Should Start on Modest Scale

TO THE EDITOR: Dr. Waddell's proposal, in the November issue, is of particular interest to me at this time, as I am arriving at the final stages of an attempt to develop construction work in South America. I recently visited there and spent some four months in studying possibilities.

In my opinion, such opportunities as exist in South America for development by North American firms involve not only problems of finance, design, and construction, but also of operation, the last being the most important and most difficult consideration. Investments of foreign capital must be repaid with interest, which must involve successful operation over such period as is required to amortize the investment.

At present, South America is adequately provided with public utilities built by foreign capital, including railways, tramways, electric power and lighting services, telephones, telegraphs, dock facilities, and similar developments. Outside capital has also built, and is operating, a variety of industrial plants, many of which are successful. It would appear then that there has been no lack of investment interest nor of engineering and construction talent for such enterprises as have been attractive from an economic viewpoint.

South America is well provided with engineering and construction talent by firms which have been established there for many years. Such organizations receive preference naturally for work which does not involve foreign financing. Only in exceptional cases can foreign engineering and construction firms obtain important work except when a project is financed by foreign capital and when that capital dictates the appointment.

After a rather wide experience in industrial engineering I am led to the conclusion that any further development in South America, along the lines outlined by Dr. Waddell, must be pioneered by specialized industrialists, who will discover profitable lines of manufacturing or similar enterprise. I do not believe that there is a field for so large an organization as is proposed. South America has passed recently through a stage of very rapid development, and is now suffering from a reaction similar to that being felt in our own country. As world conditions improve, South America will doubtless recover without large-scale construction activity from foreign sources. The first step in such improvement must necessarily be adequate financing of its present floating indebtedness.

Probably highway construction is the most pressing requirement at the moment, but for obvious reasons this is difficult to finance with foreign capital. Steps are being taken toward raising funds for this construction by gasoline taxes, and it is probable that local capital and local construction talent will undertake the work.

My suggestion would be that if Dr. Waddell's proposal is to receive favorable consideration it should be started on a more modest scale than is now proposed, and that leading industrialists should be given an important part in the organization. No doubt he is familiar with the strong "native son" sentiment that exists throughout South America, which must be a handicap to foreign development in that territory.

C. D. HOWE, M. Am. Soc. C.E.
C. D. Howe and Company, Consulting Engineers

Port Arthur, Ontario
December 10, 1931

Politics and Finance Present Obstacles

TO THE EDITOR: The suggestion for a Latin-American syndicate, as proposed by Dr. Waddell in CIVIL ENGINEERING for November, is very interesting.

From an altruistic and ethical point of view, it seems to be all that could be desired. From a practical standpoint, however, there are two major obstacles to any such scheme of development. These are as follows: (1) the political instability of South and Central American countries; and (2) the inability of these countries to pay for improvements and developments, as evidenced by the present defaults not only on sinking fund obligations, but also on the interest on present indebtedness.

Concerning the first of these obstacles, there is no question as to the vast natural resources and business opportunities in Latin America, but the principal stumbling block to the development of these is the well known mercurial character of the people—particularly those who make politics their business or profession. The constant changes in the laws governing foreign concessions and business and the numerous recent revolutions, successful and otherwise, through which Latin America has passed, are so fresh in the public mind as to need no comment. As long as such conditions persist, it will be difficult to carry out successfully any business enterprise over a long period of time.

As to the second obstacle, no matter how high the ethical ideals of the syndicate, or how high the standing of the individual engineers, contractors, and financiers composing it, the enterprises undertaken must be founded on business principles, if they are to be successful. How this is to be brought about, if the countries cannot meet their obligations, is another question that will have to be answered satisfactorily to all parties concerned, particularly investors. With the present bonds of Argentina, Brazil, Chile, Peru, and other Latin-American countries selling at only a small fraction of their original price, and the defaults that have occurred, it is a question as to how confidence can be restored.

J. H. GANDOLFO, M. Am. Soc. C.E.

Montclair, N.J.
December 28, 1931

Improving Economic Relations with Debtor Nations

TO THE EDITOR: Referring to the letter from Dr. Waddell in the November number, there seems to be no question about the latent resources of the eight million square miles of Latin America, but there is much to be considered besides latent resources.

As far as the low market quotations on Latin-American bonds are concerned, it must be noted that there are many other bargains in the security market at the present time. The cause of these depressed prices must therefore be found elsewhere than in conditions peculiar to South America. There are two universally permanent rules behind the granting of credit. First there are the willingness and ability of the debtor to meet the obligations he assumes. The second rule, which should always be kept in mind by the creditor—although it often is not—is that the intent of the creditor should be to keep a way open by which payment can be made.

With insignificant exceptions, Latin-American countries are engaged in extractive industries. Their ability to pay depends on the price and salable quantity of their commodities. The billions of dollars we have loaned them in the last twenty years were secured by faith in the continually increasing demand for commodities and the theory that relatively high commodity prices would endure forever. Even these childlike fancies would not have led us into such depths of disorder as now exist in our international economic relations. We also closed the door through which payments could be made!

Before a loan is granted the creditor controls the situation; after a loan is made the debtor becomes very important. Not only Latin America but all foreign countries are suffering from our debtor psychology and our wide-spread belief that we will be impoverished by receiving wealth from abroad. This incredible psychology of our fellow nationals permeates our legislation, our minds, and our habits. It has effectively blocked constructive activity on our part as a creditor nation. The debtor, now so important, is certainly less to blame than we are because he could hardly anticipate our refusal to accept his only means of payment, these means being obvious to all well informed persons. All the plans of mice and men will be ineffective, in so far as the rapid development of Latin America is concerned, unless we find some channel, devious though it may be, through which payment can be made.

Financial leadership must come from among the very few who know how to facilitate regular foreign payments to us, but this leadership will not be found in loaning agencies; it must come from collecting agencies, and collection is a field in which we are nationally untrained and to which we are opposed emotionally although not intellectually. Collections can be made, but hardly by engineers as such, and probably not by bankers except where their own funds are concerned. The bankers are in no sense obliged to embark on an enterprise which would be emotionally unpopular to the people not directly concerned.

As regards the suggested participation in public affairs, and especially where government is involved, we who spend much time abroad have an inviolable rule: "Avoid every direct contact with foreign politics; make friends among the people but never express an opinion regarding their emotional psychology." The principal trouble with most Latin-American governments is that they do not make the same kind of mistakes we do. They make others just as bad as ours, but we are unaccustomed to their kind of errors and hence are annoyed. In general, they understand us much better than we do them.

It is doubted that we will ultimately collect more than 25 per cent of our thirty billion dollars now outstanding in foreign credits unless we revert to the long-established principles of mercantile banking and creditor status. Collection can be made, but a change in national psychology is required, as well as an authorized organization competent to act in such matters. The greatest help which engineers can give just now would seem to be in the development of an enlightened domestic public opinion.

As collection progresses, an improving credit margin will be established. More credit may be advanced; more contracts let; and more industries built up to the desired condition. Also, more of our engineers will go abroad to supervise the expenditure of money derived from the economies of the individual bond purchasers. Until that credit margin is established through release from our debtor psychology, and we actually accept wealth in some available form, our engineers need not waste much time or thought on employment in Latin America.

VERNE LEROY HAVENS, M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.
December 18, 1931

SOCIETY AFFAIRS

Official and Semi-Official

Hoover Portrait for Engineering Societies Building

AT A BRIEF but appropriate ceremony on February 15, the four Founder Engineering Societies became owners of an oil portrait of the most noted living American engineer—President Herbert Hoover. The presentation took place in the board room of the American Society of Mechanical Engineers before representatives of the Four Founder Societies, the donors; of the United Engineering Trustees, the new custodian of the painting; and the Hoover Medal Board of Award.

It was appropriate, too, that the unveiling itself should be done by the hand of Ambrose Swasey, Hon. M. Am. Soc. C.E., who was instrumental in securing the President's permission to sit for the painting. The portrait was then presented by Gano Dunn, M. Am. Soc. C.E., chairman of the Hoover Medal Board of Award, with the following statement:

"I have the honor of unveiling and placing in the custody of the United Engineering Trustees in our temple of engineering, this vital and beautiful portrait in oils of the first member of our profession to be elevated to the high office of President of the United States.

"It is true that George Washington practiced civil engineering in his earlier career, which links him to us, but the engineering profession as we now know it did not exist in his time.

"Herbert Hoover, honorary member of each of the four great national engineering societies, and former president of the American Institute of Mining and Metallurgical Engineers, kindly sat for this portrait at the suggestion of Ambrose Swasey and at the request of the four societies.

"It was painted by that accomplished artist, Philip A. de Laszlo, of London, who has created many portraits of distinction, but none that will more inspire the engineers of the United States than this one of their fellow engineer.

"I turn it over to you, Mr. President of the United Engineering Trustees, as an additional embellishment to our great engineering societies center, where it will add one more touch of beauty and association to many we already possess, and on account of its exemplar will fire the ambition of engineers, not only to excel in the technical proficiency of their profession but to regard as included in it those broader interests of life, without which the engineer of the future cannot take his full place in the citizenship of the United States."

HERBERT HOOVER, PRESIDENT OF THE UNITED STATES
Engineer, Organizer, and World Citizen
From a Portrait in Oil by Philip A. de Laszlo

In accepting custody of the portrait President H. A. Kidder, of United Engineering Trustees, responded:

"On behalf of the United Engineering Trustees, I accept the honor of the custody of this beautiful portrait of our fellow engineer, Herbert Hoover, President of the United States, with a consciousness that in turning it over to us, the four national engineering societies desire us to cherish it as a prominent feature of the Engineering Societies Building, peculiarly associated with the growth of the engineering profession and its increasing solidarity and professional consciousness.

"We will place it where it can be seen by engineers and public alike, and where it will constantly stir the pride and emulation of the members of our profession."

The artist, Mr. de Laszlo, spoke briefly of his experiences while painting this portrait, commenting on the difficulties of relatively brief and irregular sittings. The work had to be made secondary to many other considerations and yet, he said, the President had been more than courteous, conscious of the great honor and desirous of doing his utmost to accommodate his engineering colleagues. Out of this experience Mr. de Laszlo brought a profound respect and liking for Mr. Hoover.

The exercises were simple and the audience intentionally small. Perhaps three dozen persons, largely from the Metropolitan District, were in attendance. Among those present were a relatively large group from the American Institute of Mining and Metallurgical Engineers, which was then holding its annual meeting sessions. For these engineers the ceremony was of particular interest because of Mr. Hoover's long association with the Institute, including a term as its president.

In the audience were also many Society officers and members, among them William Barclay Parsons, Arthur S. Tuttle, Otis E. Hovey, Charles A. Mead, and Ole Singstad. The painting has now been hung in the Engineering Societies Library, flanked by those of the late James Douglas, eminent mining engineer, and Ambrose Swasey. These oil portraits hang on the east wall of the main reading room, in full view as the visitor enters the library.

Mr. Hoover has been a member of the Society since 1910. He was made an Honorary Member, the highest distinction in the profession, in 1924.

Meeting of the Outgoing Board of Direction—Secretary's Abstract

On January 18 and 19, 1932, the Board of Direction met at Society Headquarters, with President Francis Lee Stuart in the chair; and present George T. Seabury, Secretary; Otis E. Hovey, Treasurer; and Messrs. Buck, Budd, Chester, Coleman, Dusenbury, Gowdy, Herrmann, Holleran, Jacobs, Lupfer, Mead, Mendenhall, Morris, Morse, Nicholson, Reichmann, Singstad, Slattery, Stevens, Thomas, Waite, and Winsor.

Annual Report of the Board of Direction

The annual report of the Board of Direction was presented and adopted.

Approval of Minutes of Board

The minutes of the meeting of the Board of Direction held on October 5 and 6, 1931, were approved.

Approval of Minutes of Executive Committee

The minutes of the meeting of the Executive Committee held on December 14, 1931, were approved, and the actions outlined therein were adopted as the action of the Board.

Policy and Program of Engineering Foundation

Approval was given to a statement outlining the policy and program of Engineering Foundation, showing the research work which it has sponsored and the qualifications possessed by the Foundation for making available through the membership of the Founder Societies the highest technical experts in all engineering lines for cooperative effort with industry and its technical problems. The Board also gave its approval to a suggested plan for the unification of money-raising efforts of the Founder Societies and Engineering Foundation in matters of technical research which would be of value to the profession and to industry.

State Councils of Professional Engineers

Supporting the recommendation of a joint committee composed of representatives of all four Founder Societies, the Board gave its approval to the formation of State Councils of Professional Engineers in those states where such councils do not now exist. The program contemplates the formation of councils within state lines with the same general member-organization characteristics as those of American Engineering Council, a national body functioning more particularly in connection with pending legislation of a national character. The State Councils of Professional Engineers are envisaged as having a similar purpose with respect to pending legislation in the respective state legislatures. Membership is to be confined to the engineering and allied societies or bodies within the state, representation to the State Council to be on a per capita basis.

Plan Entitled "The Compulsory Stabilization Reserve Fund as Business Insurance"

There was reported from the Executive Committee of the Engineering-Economics and Finance Division of the Society a plan entitled "The Compulsory Stabilization Reserve Fund as Business Insurance," by Frederick H. McDonald, Secretary of the Division. The Division submitted the plan to the Board for its consideration and "for the development of a recommendation by the American Society of Civil Engineers to American business as a step in the obtaining of a larger degree of economic security in the nation." The Board authorized the appointment of a committee to study the plan.

Construction League of the United States

The Board voted to accept the invitation for the Society to join the newly formed Construction League of the United States as a Charter Member.

Portrait of President Hoover

In cooperation with the other Founder Societies the Board accepted from the artist, Philip A. de Laszlo, the portrait for which President Hoover had sat on request of these societies. The portrait, after suitable unveiling ceremonies, will be hung in the Engineering Societies Library.

Representatives on Administrative Board of American Engineering Council

Confirmation was given to the appointment of Baxter L. Brown, Alonzo J. Hammond, John P. Hogan, and Charles E. Smith as the Society's representatives on the Administrative Board of American Engineering Council.

Reports from Advisory Committees

The Board received reports from its six Board committees; from fourteen advisory, administrative, and professional committees; from one special committee; and from three of the research committees.

Committee on Professional Conduct

The Committee on Professional Conduct reported on four matters, which were acted upon by the Board. The Board also gave formal attention to two cases being studied, looking toward expulsion. Action resulted in the expulsion of two members.

Committee on Publications

The Committee on Publications presented a report reviewing its work for the year, one feature of which was a marked reduction in the number of papers on hand, accepted but awaiting publication. The committee reported it had adhered to a policy of rigid selection of papers presented, until it could give greater assurance of prompt publication.

Committee on Districts and Zones

The boundaries of the Districts and Zones as at present defined, were adopted as those which are to apply for the year 1932.

Committee on Membership Qualifications

Reports of this Committee, presented at each session of the Board, showed that during the year consideration had been given to 509 special cases of admission and transfer.

Survey of Student Chapters

The Committee on Student Chapters presented a very carefully prepared report, showing the rather astonishing fact that 39,691 students had been in attendance at the various meetings of the Student Chapters in the past scholastic year. The report showed also the favorable consensus of opinion among the Student Chapters with respect to the lantern lectures which have been prepared and circulated. These lectures were used a total of 118 times during the scholastic year. The report also gave a complete survey of the expressed needs of the Student Chapters and it reported upon the two Student Chapter conferences which were held, one in connection with the Spring Meeting at Norfolk, Va., and the other in connection with the Fall Meeting in St. Paul, Minn.

Student Chapters Authorized

The formation of Student Chapters at the North Dakota Agricultural College, Fargo, N. D., and at the University of Delaware, Newark, Del., was approved, making a present total of 101 Chapters.

Local Section at Chattanooga Authorized

In response to a petition signed by 26 members, approval was given to the formation of the Chattanooga Section, and $60 was appropriated for its organization expenses.

Committee on Juniors

The Committee on Juniors recommended the active pursuance by the Local Sections of the program proposed by the committee last year.

Press Publicity

The Committee on Public Education reported that through the agency of the press, publicity had been given to many of the articles appearing in CIVIL ENGINEERING and PROCEEDINGS, as shown by an analysis of reports from a clipping bureau. Of a total of some 1,200 clippings received in a limited period, 576 referred to matters treated of in the Society's publications; 258 referred to the meetings of the Society; and the remainder had reference to various activities of the Society or to members.

Committee on Salaries

By the Committee on Salaries the Board was advised of satisfactory progress on the analysis of the replies to some 22,000 questionnaires sent out by the committee, from which were being

drawn conclusions as to the basic elements contributing to the rates of salaries paid civil engineers.

Committee on Meteorological Data

The report received from the Committee on Meteorological Data presented detailed results already observable from the uncompleted study of the work of the Weather Bureau as related to the problems of civil engineers. Adopting a recommendation of the committee, the Board authorized the appointment of a subcommittee to effect closer contact with the Department of the Interior at Washington, D.C.

Earthquake Committee's Report

In its consideration of the budget, the Board found it impossible to provide for the publication of the report of the Special Committee on Effects of Earthquakes on Engineering Structures. It suggested, however, the deposition of copies in important libraries where the report could be accessible to interested engineers. It also adopted a formal expression of appreciation to the committee for the vast amount of labor it had performed. The committee consisted of J. D. Galloway, Chairman; F. H. Fowler, John Millis, C. H. Snyder, and C. B. Wing, Members Am. Soc. C.E., and Isami Hiroi.

Fall Meeting at Atlantic City

Provision was made in the budget for the holding of the 1932 Fall Meeting of the Society at Atlantic City at the invitation of the Philadelphia Section of the Society.

Summer Meeting at Yellowstone

The previous decision to hold the Convention in the early summer at Yellowstone Park was confirmed by the necessary budget appropriations.

Proposed Budget for 1932

The proposed budget for 1932, as recommended by the Executive Committee, was discussed in detail, amended somewhat, and recommended to the incoming Board for adoption.

Meeting of the Incoming Board of Direction—Secretary's Abstract

The Board of Direction met at the Headquarters of the Society on January 21, 1932, with President Herbert S. Crocker in the chair; and present George T. Seabury, Secretary; Otis E. Hovey, Treasurer; and Messrs. Black, Buck, Chester, Coleman, Enger, Gregory, Henny, Herrmann, Hoffmann, Holleran, Lupfer, Mead, Mendenhall, Riggs, Singstad, Slattery, C. H. Stevens, J. C. Stevens, Stuart, Thomas, Tuttle, and Waite.

Water Works Betterment for Unemployment Relief

Messrs. Harrison P. Eddy and Malcolm Pirnie, Members Am. Soc. C.E., appeared before the Board and presented and explained the plan for water works betterment for unemployment relief, prepared by a committee of the American Water Works Association with the approval of its board of directors. The plan demonstrates the economic values to be derived and suggests necessary financial remedial measures. The Board approved the plan in principle.

Ithaca Local Section

The formation of a Local Section to be known as the Ithaca Section in response to petition of interested members in the neighborhood of Ithaca, N.Y., was approved, and an appropriation of $60 for its use was incorporated in the Budget.

Budget for 1932

In its consideration of the Budget, the Board decided to defer for this year its publication of the pamphlet, *Aims and Activities*, which is usually issued in April or May. The Budget for 1932 as amended in several administrative details by both the outgoing and incoming Boards was adopted.

Special Committees

The following personnel for committees for 1932 was approved, the President being given authority to complete it and to fill vacancies where necessary.

EXECUTIVE COMMITTEE: Herbert S. Crocker, Chairman; J. N. Chester, J. F. Coleman, Charles A. Mead, Francis Lee Stuart, and Arthur S. Tuttle.

COMMITTEE ON HONORARY MEMBERSHIP: Herbert S. Crocker, Chairman; J. N. Chester, J. F. Coleman, D. C. Henny, Francis Lee Stuart, Arthur S. Tuttle, and H. M. Waite.

COMMITTEE ON DISTRICTS AND ZONES: F. C. Herrmann, Chairman; Robert Hoffmann and E. K. Morse.

COMMITTEE ON PROFESSIONAL CONDUCT: J. F. Coleman, Chairman; Henry E. Riggs, John R. Slattery, J. C. Stevens, and Franklin Thomas.

COMMITTEE ON PUBLICATIONS: Charles H. Stevens, Chairman; Henry R. Buck, L. G. Holleran, Edward P. Lupfer, and Ole Singstad.

COMMITTEE ON MEMBERSHIP QUALIFICATIONS: Allan T. Dusenbury, Chairman; M. L. Enger, D. A. MacCrea, H. D. Mendenhall, and Franklin Thomas.

COMMITTEE ON RESEARCH: T. Chalkley Hatton, Chairman, term ending January 1933; V. R. Covell, term ending January 1934; Thaddeus Merriman, term ending January 1935; George E. Beggs, term ending January 1936; and John H. Gregory, Contact Member.

COMMITTEE ON LOCAL SECTIONS: Robert Follansbee, Chairman, term ending January, 1934; Murray Sullivan, term ending January 1933; N. T. Veatch, term ending January 1935; F. G. Jonah, term ending January 1936; and E. B. Black, Contact Member.

COMMITTEE ON JUNIORS: E. N. Noyes, Chairman, term ending January 1933; A. M. Lund, term ending January 1934; H. P. Treadway, term ending January 1935; J. T. L. McNew, term ending January 1936; and D. A. MacCrea, Contact Member.

COMMITTEE ON STUDENT CHAPTERS: O. M. Leland, Chairman, term ending January 1933; J. J. Doland, term ending January 1934; T. A. Leisen, term ending January 1935; C. C. Williams, term ending January 1936; and Edward P. Lupfer, Contact Member.

COMMITTEE ON ENGINEERING EDUCATION: Daniel W. Mead, Chairman, term ending January 1933; A. H. Fuller, term ending January 1934; H. F. Ferguson, term ending January 1935; Clarence L. Eckel, term ending January 1936; and Henry E. Riggs, Contact Member.

COMMITTEE ON PUBLIC EDUCATION: C. J. Tilden, Chairman, term ending January 1933; W. D. Binger, term ending January 1934; Abel Wolman, term ending January 1935; D. H. Sawyer, term ending January 1936; and Charles H. Stevens, Contact Member.

COMMITTEE ON LEGISLATION: R. E. Koon, Chairman, term ending January 1933; Albert Givan, term ending January 1934; Ralph J. Reed, term ending January 1935; E. J. Schneider, term ending January 1936; and F. C. Herrmann, Contact Member.

COMMITTEE ON REGISTRATION OF ENGINEERS: T. Keith Legaré, Chairman, term ending January 1933; L. L. Hidinger, term ending January 1934; R. E. Warden, term ending January 1935; Willard T. Chevalier, term ending January 1936; and Ole Singstad, Contact Member.

COMMITTEE ON SALARIES: E. P. Goodrich, Chairman; A. B. McDaniel, E. O. Griffenhagen, W. F. Reeves, Arthur Richards; and John R. Slattery, Contact Member.

COMMITTEES ON MEETINGS:

Annual Meeting: Arthur S. Tuttle, Chairman; L. G. Holleran, Charles A. Mead, Ole Singstad, and John R. Slattery.

Spring Meeting: J. N. Chester, Chairman; Allan T. Dusenbury, John H. Gregory, D. A. MacCrea, and H. D. Mendenhall.

Summer Meeting: D. C. Henny, Chairman; E. B. Black, F. C. Herrmann, J. C. Stevens, and Franklin Thomas.

Fall Meeting: H. M. Waite, Chairman; Henry R. Buck, M. L. Enger, Robert Hoffmann, Edward P. Lupfer, E. K. Morse, Henry E. Riggs, and Charles H. Stevens.

COMMITTEE ON TECHNICAL PROCEDURE: Herbert S. Crocker, Chairman; Edward Bartow, L. J. Bevan, William Bowie, Henry R. Buck, J. L. Burkholder, W. T. Chevalier, R. W. Crum, J .C. Gotwals, A. P. Greensfelder, T. Chalkley Hatton, Edward N. Noyes,

D. B. Steinman, Charles H. Stevens, H. M. Waite, and George T. Seabury, Secretary.

COMMITTEE ON PROFESSIONAL ACTIVITIES: Herbert S. Crocker, Chairman; E. B. Black, F. C. Herrmann, Edward P. Lupfer, D. A. MacCrea, Henry E. Riggs, Ole Singstad, John R. Slattery, Charles H. Stevens, and George T. Seabury, Secretary.

COMMITTEE ON ACCREDITED SCHOOLS: A. E. Morgan, Chairman, term ending January 1933; C. M. Spofford, term ending January 1934; Morris Knowles, term ending January 1935; Milo S. Ketchum, term ending January 1936; and Franklin Thomas, Contact Member.

Translation Service Available

The Engineering Societies Library has been actively occupied in translating papers to be presented by foreign engineers and scientists at the Third International Coal Conference, which recently met at the Carnegie Institute of Technology.

Translators of technical writings encounter many difficulties. Technical dictionaries are in general very defective and, in addition, workers in advancing fields of knowledge constantly invent new words and new meanings for old ones. The translator must draw upon his knowledge of the subject for appropriate equivalents for these, as dictionaries give little help.

During its years of work, the Engineering Societies Library has gained a reputation for accurate work. It is gratified that the authorities in charge of the Coal Conference selected it for this important task.

Local Sections Meet Unemployment Problem

Important among the accomplishments of the Local Section committees on unemployment relief is the cooperation secured from employing firms. Coordination of effort and interchange of ideas between the committees and business groups have resulted in the creation of immediate emergency jobs and will also be a valuable aid in getting men back into permanent engineering positions. Notable in this connection are the conferences reported in Sacramento, Calif., and Birmingham, Ala., as a result of which employers gave immediate "relief jobs" to men they had laid off who were in distress. These employers also provided free return transportation for those whom they had brought into the industrial centers. Besides such definite results as these, other cities have reported a mutual understanding between employers and relief committees that is of distinct benefit to the unemployed.

Although in this Local Section work emphasis has been placed on immediate relief rather than on "long-time" employment stabilization, several of the Sections have done work of a permanent character. In Columbus, Ohio, and in Denver, Colo., particularly, surveys of engineering firms have been undertaken to determine the possibilities for the future placing of men. These surveys, sponsored by the employing firms and made by the engineers, serve to point out employment possibilities and difficulties, and are considered of mutual benefit.

Organization of the Local Sections for this relief work has been undertaken on an expanding scale and carried as far as each Section felt practicable in its own case. The work has consisted of three parts: first, a canvass of Local Section members, which in most cases revealed no great distress; second, a canvass of members of all engineering societies residing in the community and adjacent territory; third, a widespread movement, like that in California, in an attempt to list all the engineers of the state and help all who are in distress.

In a number of the Sections loan funds have been set up and small loans have been made to needy engineers. San Francisco and New York have found this form of relief most necessary. Other Sections have provided such aid on a much smaller scale but in just as kindly a manner.

One of the duties of the Local Section committees is to keep up the morale of unemployed engineers. The idea that courses of study be outlined for such men has been quite generally approved. Among other educational institutions, Ohio State University recently opened a number of special courses that engineers may attend without charge.

The principal work of the Local Section committees has been to find and superintend "made-work" projects that will furnish employment not only to engineers but also to the general class of needy in the community. This planning of course varies in different places. Some of the original ideas put in practice are applicable to various localities and are being exchanged by the committees and adapted to local needs. A few of these ideas are of general interest and are listed as follows:

1. In Milwaukee unemployed engineers were given the task of relocating and reestablishing section-corner markings throughout the state. There was no state appropriation for this important work and it therefore became an ideal "made-work" project.

2. In Denver the committee paid unemployed engineers from its own funds to estimate and plan public improvements that might be used to give employment to the general class of needy, who were to be paid from the community chest.

3. In Iowa each county highway engineer is a committee of one to report any unemployed engineers in his county and give information as to the seriousness of their need. The county engineer also reports any possibilities of employment in his county.

4. In Cincinnati, the Rochester Plan, a general property improvement plan, is being used. Engineers paid from committee funds are sent out to estimate and make plans for such improvement. The property owner may or may not employ the engineer making the estimate to do the work, but it has been found that this employment usually follows.

5. In Boston an organization which it is hoped will be permanent has been set up to serve as a public planning board as well as a relief organization. In cooperation with the City Planning Commission, real estate boards, and other public and semi-public organizations, the Boston committee is planning not only to employ its 1,000 idle engineers but also to further public safety and welfare. A branch of the committee is giving immediate relief in the form of loans and emergency jobs.

6. Expanded topographic mapping is being used in a number of states as a relief measure. Local Sections particularly active in this direction are the Northwestern, Philadelphia, Georgia, Louisiana, and Metropolitan.

7. In Seattle, an effort is being made to work with other relief agencies in providing emergency jobs for the unemployed and at the same time to outline a broad plan of stabilization.

8. In Kansas City, work on the city streets has been expanded to take up most of the slack in employment.

In all of the 41 Sections of the Society in which relief work in some form is going forward, some amplification or adaptation of the foregoing plans is being used to provide emergency jobs. In every part of the United States engineers are showing a willingness to meet the unemployment problem in their own localities.

Report of Society Committee on Salaries

BY E. P. GOODRICH, CHAIRMAN

During the year 1931 the Committee on Salaries (of engineers in public and quasi-public offices) directed its activities, first, toward the analysis of the answers to the questionnaires that were distributed a year ago; and second, toward endeavors through professional self-help measures to prevent salary reductions.

The questionnaires were analyzed by Arthur N. Richards, M. Am. Soc. C.E., a member of the Committee on Salaries, who has compiled a report containing 38 pages of text and 73 diagrams. Although the committee was unfortunate in not securing answers from a proper proportion of the men in the lower grades (so that the results are doubtless above the true average), and even though there is no such person as an "average" engineer, still it is interesting to note that the median salary disclosed by the analyses made by Mr. Richards (on the basis of approximately 7,000 men) is almost exactly $4,000, and the average is $4,250. These figures may be compared with the data secured by a committee of this Society in 1915, those collected by a committee of the American Engineering Council in 1919, and those compiled by a committee of the Society for the Promotion of Engineering Education in 1926. The averages, which are not strictly comparable, are as follows:

DATE	ORGANIZATION	AVERAGE
1915	American Society of Civil Engineers	$3,986
1919	American Engineering Council	4,032
1926	Society for the Promotion of Engineering Education	4,275
1930	American Society of Civil Engineers	4,250

The accompanying diagram, Fig. 1, which is typical of the charts

prepared by Mr. Richards, gives the annual salaries for the year 1930 of the 7,000 men previously mentioned and shows the salary distribution by 10 per cent groups, arranged in ten different classifications. For example, of the men of the grade usually designated "assistant engineer," 68 per cent received $2,600 or more, while 24 per cent received $3,600 or more. The median salary of men with the title of "chief engineer" was $6,200.

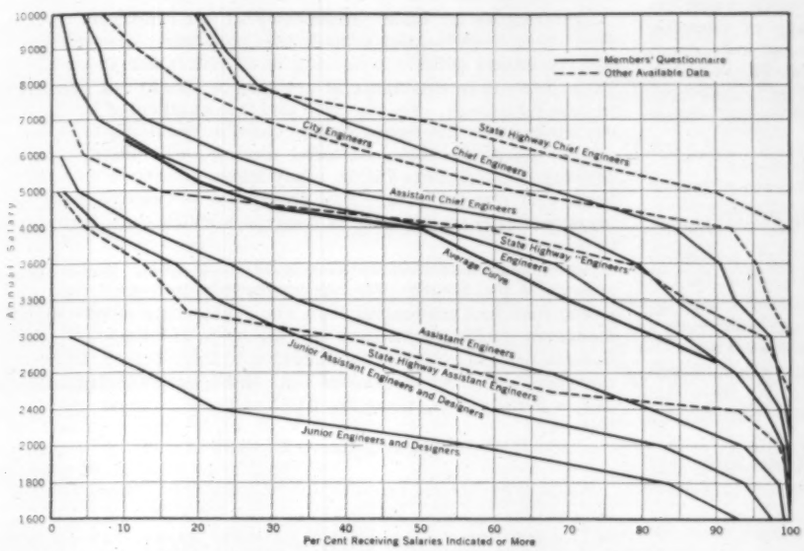

FIG. 1. SALARY CHART FOR CIVIL ENGINEERS, 1930

Many other comparisons can be made from this and the other diagrams. One of the most interesting of these shows that the average total salary income of approximately 500 engineers who served with the same organization for the entire 20-year period covered by the questionnaires exceeded by about $7,000 the same average for approximately 750 engineers who served with several organizations during that period. Among "chief engineers," the median man received an average annual increment of $100 per year between 1911 and 1930.

The committee will doubtless make an endeavor to secure further information about the salaries of men in the lower grades, and will then turn its attention to discovering the causes of the wide variations which were disclosed by the recent study. Further contemplated subjects include a correlation between salary schedules and typical organization groups, with the final aim of finding measures which can be employed in raising the various salaries to amounts which seem commensurate with the services the engineering profession is rendering to the public.

UNEMPLOYMENT PROGRAM IN OPERATION

Especially during the past year country-wide economic conditions have created strong tendencies toward salary cutting. The committee felt its duty was to combat these tendencies. Consequently a study was made of the most effective steps which could be taken. These seemed to be the creation, in the various Local Sections, of special committees charged with the duty of ascertaining the facts as to unemployment among engineers and of extending assistance furnished by the more fortunate ones to their professional brethren in need of aid.

This program was approved by the Board of Direction of the Society at the St. Paul Meeting, and Table I shows the results which had been reported to February 10, 1932. Some action had been taken by 42 Sections; 37 had reported the making of a survey; 23 had machinery for the administration of relief, and others were making plans to take such measures; 7 Sections had set up relief funds; and 10 Sections had reported that the plans proposed by the committee were not applicable to their local conditions. No data had been received from 11 Sections, while 12 engineering clubs and societies reported cooperation along lines comparable with those suggested by the committee.

A number of local engineers' clubs and societies—in Boston, Birmingham, Grand Rapids, Mich., Hawaii, New Jersey, Dayton, Des Moines, Mohawk Valley, Springfield, Florida, Philadelphia, and Trenton—are working with the Local Sections of the Society in their localities or are cooperating directly.

The general scheme has received the distinguished support of the President of the United States, who contributed $5,000 to be used in an appropriate manner. While this contribution was sent to the New York organization, it has been decided to employ it, together with other general contributions, for the country-wide problem.

In many communities, all engineers, regardless of their professional specialty or society membership, have joined forces. In New York, for example, the committee includes not only members of the Society, but also those of the other Founder Societies. In addition, chemical engineers and the wives and families of engineers are assisting. Non-members as well as members are being aided. By the middle of January, gifts and pledges amounting to approximately $70,000 had been received; 1,450 men had been registered; 685 had been placed; and loans had been made to 37 men. The machinery is working smoothly with what is felt will be material benefit both in economic assistance and professional solidarity. In some instances the conditions encountered in various parts of the country have been pathetic in the extreme. In the New York registration office, two men fainted for lack of food.

The attention of the committee was called to the fact that certain unencumbered congressional appropriations exist which might be applied in large measure to the employment of engineers in the topographic mapping of the country, provided that the several states and interested cities could be induced to make appropriations to match allotments from the Federal funds available to the Department of the Interior. Information as to this possibility was disseminated among the various Sections, and John P.

TABLE I. STATUS OF UNEMPLOYMENT RELIEF BY LOCAL SECTIONS

LOCAL SECTION	REPORT SOME ACTION	REPORT SURVEY	ADMINISTERING RELIEF	RELIEF FUND
Alabama	x	x	x	x
Colorado	x	x	x	x
Milwaukee	x	x	x	x
New York	x	x	x	x
Northeastern	x	x	x	x
Sacramento	x	x	x	x
San Francisco	x	x	x	x
Central Illinois	x	x	x	...
Central Ohio	x	x	x	...
Cincinnati	x	x	x	...
Iowa	x	x	x	...
Kansas City	x	x	x	...
Lehigh Valley	x	x	x	...
Maryland	x	x	x	...
North Carolina	x	x	x	...
Northwestern	x	x	x	...
Philadelphia	x	x	x	...
Pittsburgh	x	x	x	...
San Diego	x	x	x	...
Seattle	x	x	x	...
Texas	x	x	x	...
Los Angeles	x	...	x	...
Louisiana	x	...	x	...
Buffalo	x	x	...	...
Dayton	x	x	...	...
Detroit	x	x	...	...
District of Columbia	x	x	...	...
Duluth	x	x	...	...
Florida	x	x	...	...
Georgia	x	x	...	...
Illinois	x	x	...	...
Miami	x	x	...	...
New Mexico	x	x	...	...
Panama	x	x	...	...
Portland	x	x	...	...
Porto Rico	x	x	...	...
St. Louis	x	x	...	...
Toledo	x	x	...	...
Virginia	x	x	...	...
Providence	x	...	...	...
Syracuse	x	...	...	...
Utah	x	...	...	...

Hogan, M. Am. Soc. C.E., was instrumental in securing an appropriation from the State of New York. Certain other states have taken steps in this direction, but, as far as is known, none has yet completed the necessary procedure.

To every man in the profession a great opportunity is now offered. Not only should he study ways and means of effecting immediate relief, maintaining morale, and creating professional solidarity, but he should give the most intense thought of which he is capable to solving the problem of the causes which have brought about this world-wide condition, and to possible cures for it.

Appreciation of Earthquake Committee

The Society's Special Committee on Effects of Earthquakes on Engineering Structures has represented a worthwhile effort for the formulation of engineering principles of wide and useful application. The history of this work goes back to October 1923, when a committee was formed to study the effects of earthquakes. Although the scope of their work was broad, definite thought was given to the great Japanese earthquake and accordingly the membership of the committee was extended to include outstanding engineers on both sides of the Pacific.

After comprehensive study, an extensive report was submitted to the Society in 1929. Since that time continuous efforts have been made to finance its publication. Each year the Society's budget has contained some provision for this purpose; but unfortunately, the necessary cooperation from other organizations has not been feasible, so that publication had to be periodically deferred. Again this year the matter came up, and again the hopes of somehow financing the publication were disappointed.

In consideration of the extensive work done by the committee for the benefit of the profession, the Board of Direction at its recent meeting placed its sentiments on record in the following resolution:

> "The Board appreciates the vast amount of labor done by the Special Committee on Effects of Earthquakes on Engineering Structures in formulating its extensive report and realizes that this work has great value to the profession. It therefore regrets that it is obliged to take action adverse to the inclusion of this report in the Society's publication program for 1932, due to the budgetary limitations during the coming year."

It is hoped that copies of the complete report may be placed on file in libraries on both the Atlantic and Pacific coasts in order that all engineers may have the privilege of consulting them. This valuable work and report have been effected by the committee, including the following personnel: J. D. Galloway, chairman; F. H. Fowler, John Millis, C. H. Snyder, and C. B. Wing, Members of the Society; and Isami Hiroi, of Tokyo, Japan.

Snap Shots of 1931

EXTRACTS FROM ANNUAL REPORT OF THE BOARD OF DIRECTION

The year has been one of consolidation of position rather than one of planning for further objectives. It closed with a better financial result than might be expected, a fact that is the more significant in the light of several circumstances.

* * * * *

By conservative administration, the year has closed with the withdrawal of only approximately $13,000 from the accumulations of previous years. Such trust and other funds as the Society has in the form of securities have necessarily suffered in market value, but happily the total depreciation from purchase prices is less than 17 per cent and the Society is under no particular stress to dispose of them. All of the Society's property is invested; the major portion in such form as to return a fixed annual income applicable to current expenditure.

The dues collected in 1931 averaged $16.53 per member, whereas the disbursements, the largest in the history of the Society, were equivalent to $27.15 per member. Forty per cent of the Society's service to members, it will be seen, therefore, is carried on out of income arising from other sources than dues, that is, largely from the sale of publications, advertisements in CIVIL ENGINEERING, the rental of the 57th Street property, and the return from the investment in the building in which the Society is housed.

* * * * *

Applications fell off approximately 22 per cent from the high year, 1927, but the net growth this past year, nevertheless, is 531, making a total membership as of December 31 of 15,190. Two elements in this figure of net growth should not be allowed to pass unnoticed. On the one hand it is augmented by the lenient attitude of the Board of Direction in remitting the dues of certain members under financial distress, who have faithfully supported the Society for, in many cases, twenty or even thirty years. It was the pleasure of the Board to remove from these loyal members the pressure of back dues which they were unable to pay.

The other significant detail contributing to the sustained net growth of the Society was the continued interest shown by the young men just graduating from the engineering schools and immediately seeking admission as Juniors in the Society. Today the number of Juniors in the Society is 618 per cent of the number ten years ago. At the end of 1921 there were 458 Juniors; today, a decade later, there are 2,835 of these younger men in the Society.

* * * * *

Aside from several important psychological effects derived, the publication of CIVIL ENGINEERING has provided for an increase of 17.5 per cent in the volume of technical matter available to the membership. The contribution to technical literature in 1929, through the PROCEEDINGS, could be measured as 1,867,000 words. For the year 1930, a comparison would be misleading, but for this year the corresponding figure for PROCEEDINGS, CIVIL ENGINEERING, Manuals, and including Memoirs, is 2,193,000 words.

* * * * *

The Engineering Societies Employment Service is not in any sense a manufacturer of jobs. Rather is it a mart for the exchange of commodities, jobs on the one hand and services on the other, and in this year of curtailment on all sides, the function of the Employment Service as an exchange has necessarily suffered. In 1929, its year of maximum influence, the Service made profitable contacts for 1,664 engineers. In 1931, this figure fell to 691 but it remains significant that even in its poorest month, December last, it was able to direct 35 engineers to full-pay positions.

* * * * *

In many respects the Society may be likened to an industrial or manufacturing process, in that through the medium of the staff the contributions of individual members are to be returned to the membership as a coordinated product. Members to the number of 1,073 contributed directly to the Society's administration. Members to the number of 1,478 contributed individually to its technical publications, and 738 members were engaged on its technical committees, a total of 3,289 individual contributing members.

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The business conducted in 1931 is almost exactly double that of the year 1921, another interesting comparison permissible with conditions existing only a decade ago.

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The continued growth of Society membership and the increase in the volume of Society publications has necessitated a staff now numbering 53, a figure nearly double that of 11 years ago, a third permissible comparison with conditions of a decade ago.

* * * * *

Properly to be recorded as an adopted Society policy is the reply made to the request by American Engineering Council of its member organizations, wherein the Society sets forth that it favors the registration of engineers.

* * * * *

At the suggestion and through the generous financial aid of Past-President and Honorary Member John R. Freeman, Professor Suyehiro was invited to deliver a series of lectures on the

application of engineering principles in the design of structures to resist earthquake shock. In October and November last he lectured before various universities, societies, and clubs on both sides of the continent. Through a combination of Professor Suyehiro's generosity in relinquishing a considerable part of his honorarium, the continued generosity of Mr. Freeman, and the use of Society funds, these lectures will be printed by the Society.

* * * * *

The following table shows the new members and the net increase in membership:

	1928	1929	1930	1931
New Members	1,244	1,066	1,139	1,055
Net Increase	820	508	574	531

During the year there were twenty Division programs, of which two were double sessions, and two were joint sessions of two Divisions.

The Engineering-Economics and Finance Division, organized at the 1931 Annual Meeting, held its first session at the 1931 Fall Meeting in St. Paul, Minn.

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There are at present 99 Student Chapters, of which the following were organized during 1931:

Harvard Engineering Society (Harvard University)
Michigan College of Mining and Technology
Newark College of Engineering
Pennsylvania Military College.

* * * * *

A payment of $15,000 was made on the mortgage.

Order Reprints from Proceedings

Authors and readers of PROCEEDINGS should be forewarned that the process of assembling material for Volume 96 of TRANSACTIONS has begun. There are many who will want a hundred or more reprints of certain papers that have been published during the current year. If definite orders for such reprints are placed at Headquarters promptly, it will be possible to get the work done at considerably reduced prices. This reduction in price is passed on to the member. However, if an unusually large order is received after a paper has been taken from the presses, an extra charge must be made and in some cases the difference is considerable. Orders received now will be held until the paper is run. Rough estimates can be made as to the maximum cost.

Spring Meeting Omitted

For some time the probability of being able to hold the 1932 Spring Meeting, scheduled for Miami, Fla., in April, has been doubtful. This outcome has been confirmed by action of the Board of Direction at its January Meeting, officially approving the omission of any Spring Meeting for the coming year.

The next Quarterly Meeting will therefore be the Sixty-Second Annual Convention, to be held during the summer. It has been scheduled for Yellowstone National Park. Already plans are being laid for a worthwhile gathering, details of which will be announced in plenty of time to give all members an opportunity to arrange for including a visit to this national playground in their summer plans.

It is hoped that many who might otherwise have found themselves able to travel to Miami this spring will transfer their thoughts to the Annual Convention.

An Ethical Question Answered

A hypothetical question presented to the Board of Direction was submitted to the Committee on Professional Conduct. The question and the committee's answer follow:

Question:

Is it unprofessional and unethical for a member of the Society engaged in the building material business, to offer engineering services to architects or others, in direct competition with other members of the Society engaged in independent engineering?

Answer:

It does not appear to be unprofessional or unethical for a member of the Society engaged in any business to offer engineering service in competition with other members of the Society, providing that in doing so he does not:

1. Attempt to supplant another engineer after definite steps have been taken toward his employment.
2. Reduce his usual charges and in this manner attempt to underbid after being informed of the charges named by another.

We do not believe the mere fact that a member of the Society is engaged in the building material business disqualifies him for general civil engineering practice. The fact that he is engaged in such business may, because of his anxiety to introduce the articles produced or for sale, have a tendency to influence him to unethical practice.

Under the present industrial methods, many industries furnishing structural materials employ competent engineering offices, qualified to give advice with regard to the manufacture and uses of their products. The discontinuance of such engineering offices by the industries and dealers would, undoubtedly, broaden the field and give more employment to the engineer engaged solely in professional practice; at the same time, however, it would probably throw out of employment many engineers well qualified to design, advise, and construct, and deprive the owners and architects of services of engineers especially qualified to advise in regard to special materials and their uses.

United Engineering Trustees Elects Officers

In 1904 the United Engineering Trustees was established as the United Engineering Society "to advance the engineering arts and sciences in all their branches, to further research in science and engineering, to maintain a free public engineering library, and to advance in any other manner the profession of engineering and the good of mankind."

For its constituent societies—the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers—it owns and administers the Engineering Societies Building at 29 West 39th Street, certain endowment and other funds, and various properties committed to it. Through the Engineering Foundation, the Library Board, and the Administrative Department, it aids research in engineering and the sciences, operates the Engineering Societies Library, and carries on other activities.

For the year 1932, Harry A. Kidder, a fellow of the American Institute of Electrical Engineers, has been elected president of the United Engineering Trustees, Inc. Those named as vice-presidents were Harold V. Coes and Col. Arthur S. Dwight. Dr. Alfred D. Flinn, M. Am. Soc. C.E., Director of the Engineering Foundation, will serve as secretary, and Clifford P. Hunt, as treasurer. Members of the Board of Trustees for 1932 representing the Society have been designated as follows: Charles A. Mead, Arthur S. Tuttle, and Frank E. Winsor, all Members Am. Soc. C.E.

Engineering Societies Library Has Active Year

According to the annual report of Director Harrison W. Craver, the year 1931 was the most active in the history of the Engineering Societies Library. Surpassing all previous records, the Library responded to 42,659 requests for technical information, an increase of 2,577 over 1930. The Library's service extended to practically every country in the world.

A total of 27,943 visitors, 10 per cent more than in 1930, taxed the seating capacity of the Library, indicating that "the time is approaching when additional space will be needed." Valuable book collections were acquired, and more than $50,000 was expended during the year.

According to the report, "the general condition of the Library is excellent. Through the Professional Engineers Committee on

Unemployment, and the Unemployment Relief Committee of New York, the Library has had the services of several men. This has made it possible to rearrange the stacks, to make many minor repairs to books, and to accomplish a large amount of work for which the staff could not spare time from regular duties."

"On December 31, 1931, the collection numbered 127,949 books, 5,000 pamphlets, 6,498 maps, and 4,646 searches, a total of 144,093 . . . . The index to the catalog contains 37,591 subjects and the catalog contains 450,939 cards."

The periodical index now includes 27,000 references to important articles. More than 13,000 entries were added in 1931. Inquiries from 5,946 members were answered by telephone and 3,620 others were assisted by mail.

The increased use of the Library is attributed by Mr. Craver to the "growing appreciation of the wealth of information readily accessible upon our shelves. Daily observation shows that increasing numbers of members turn regularly to the Library for professional reading and that the usefulness and comprehensiveness of the collection is becoming better and better known."

Appointments of Society Representatives

H. J. GILKEY and C. L. POST, Members Am. Soc. C.E., have been appointed Society representatives to fill two vacancies on the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete.

R. C. MARSHALL, JR., D. H. SAWYER, and EZRA B. WHITMAN, Members Am. Soc. C.E., have been appointed Society delegates at the thirty-sixth annual meeting of the American Academy of Political and Social Science.

Honoring Alfred Noble

In a previous issue of CIVIL ENGINEERING announcement was made of the award of the Alfred Noble prize this year for the first time. Quoting from a letter by President Crocker to the recipient, Prof. Corbin T. Eddy, this prize was "instituted to commemorate a great man—a leading figure in the field of engineering, who will always live in the memories of those who knew him for his qualities of mind and heart."

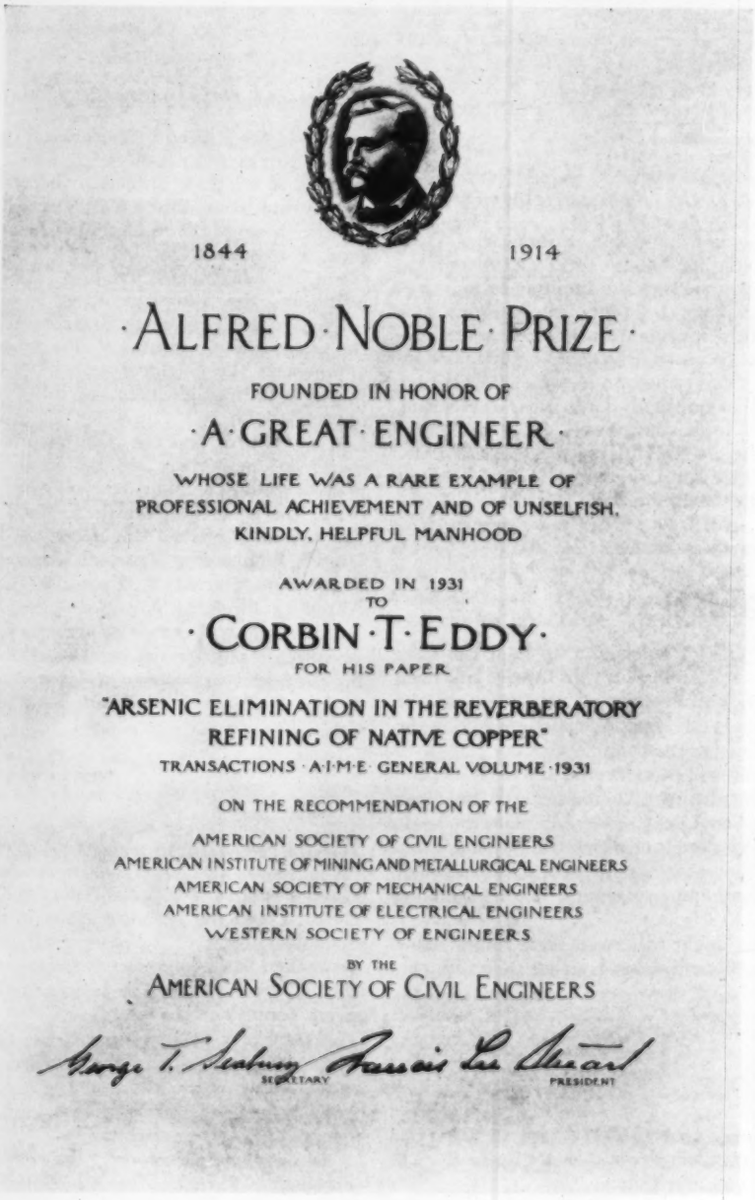
"Alfred Noble," the letter continues, "reached the full span of three score years and ten. In those years, nearly fifty of which were spent in the practice of his chosen profession, he not only made a name for himself as a civil engineer, but he won the esteem and affection of all who were associated with him. His interest in the younger members of the profession has prompted his friends to establish this award in his name for the benefit of these younger engineers, to stimulate their technical activities, and to put before them the example of achievement which is shown in his life.

"Born and reared on a farm, Mr. Noble enlisted at the age of 18 in the Union Army, and served as a private for three years. Returning to his studies, he was graduated from the University of Michigan. His civil engineering work began in the service of the Government, on the canal at Sault Ste. Marie, Michigan. Later he designed and built a number of bridges in association with George S. Morison. In 1894 he entered private practice as a consulting engineer. Among the many projects in which he had a prominent part are the Panama Canal, the Pennsylvania Terminal in New York City, the Galveston sea wall, and the Catskill Water Supply of the city of New York.

"In the activities of the American Society of Civil Engineers, Mr. Noble had a vital share during the forty years of his membership. He served the Society as Director, as Vice-President, and as President, and on a number of committees. He was president also of the Western Society of Engineers, and of the American Institute of Consulting Engineers, and a member of the Board of Managers of the American Society of Mechanical Engineers. His contributions to professional literature may be found in the publications of these societies and in the technical magazines.

"Mr. Noble interested himself in the question of the registration of engineers, and in the establishment of the Engineering Societies Library. In the half century of his active professional life, he rendered valuable service to his fellow citizens by his counsel in numerous engineering projects, involving public welfare and safety. In his contacts with other engineers, his outstanding characteristics impressed themselves upon his generation and that which followed. His modesty, his faithfulness to his friendships and to his work, his generosity and human kindness will be long remembered. His death, in the year 1914, brought to an end a career which may well be emulated by those who never had the privilege of knowing him."

The certificate of award, reproduced here, includes a portrait of Mr. Noble as well as a mention of his personal and professional attainments.



American Engineering Council

National representative of 26 engineering societies, with a constituent membership of 60,000 professional engineers, reports civil engineering news of the Federal Government

ANNUAL MEETING OF ASSEMBLY

Attended by representatives from each of the 26 engineering societies, the Assembly of American Engineering Council held its annual meeting in Washington, D.C., January 14–16, 1932.

William S. Lee, M. Am. Soc. C.E., former president of the American Institute of Electrical Engineers, was chosen president for the two-year term, 1932–1933. The four vice-presidents are: O. H. Koch, R. C. Marshall, Jr., L. B. Stillwell, and D. Robert Yarnall, all Members Am. Soc. C.E.; and Farley Osgood was elected treasurer. These officers, with A. J. Hammond, M. Am. Soc. C.E., Chairman of the Finance Committee, constitute the Executive Committee for 1932.

STATE COUNCILS OF PROFESSIONAL ENGINEERS

A joint committee composed of representatives of the American Institute of Electrical Engineers, the American Society of Civil Engineers, the American Society of Mechanical Engineers, and the American Engineering Council, had formulated recommendations on the subject of state councils of professional engineers. The Assembly voted to adopt the recommendations which follow:

1. It is deemed essential for the advancement of the engineering profession that there be organized a state council of professional engineers in each state in which such a council does not already exist.

2. Each state council should be composed of representatives of the local sections of national engineering societies and the engineering and allied technical societies within the state.

3. The purpose of these councils should be to enable the engineering and allied technical organizations to render a more effective public service and to contribute to the advancement of these professions. They may through appropriate channels communicate to the proper representatives of the state governments, advice and suggestions relative to questions of legislation or administration, in the solution of which engineering and allied technical knowledge and experience may be involved or valuable, and may upon the request of local or regional organizations, or in the absence of such organizations, render similar service in local affairs.

4. Membership in these councils should consist of any society or organization of the engineering or allied technical professions within the state whose chief object is the advancement of the knowledge and practice of engineering or of allied sciences, or the promotion of the interests of engineering or allied technical professions which are not organized for commercial purposes. Membership in these councils should not be granted to individuals.

5. The encouragement of the formation of State Councils of Professional Engineers by the governing boards of the several societies is urged.

LEGISLATIVE ACTIVITIES

Action taken by the Assembly on some of the important legislation pending in Congress is given below:

The Green bill, H.R. 6187, a bill to direct the Secretary of the Treasury to contract for architectural and engineering services in the designing and planning of public buildings, was supported with the recommendation that an effort be made to have the bill amended in certain respects.

The proposal of Congressman Hall of Mississippi, embodied in H.R. 6995, which would authorize the Secretary of the Interior to grant a moratorium on payment of construction charges on reclamation projects, was condemned.

There have been introduced into Congress several bills which propose to reorganize the public works activities of the Federal Government by creating an Administration of Public Works. After a careful analysis of these measures, the Public Affairs Committee recommended, and the Assembly approved in principle the proposal of Mr. Cochran of Missouri, chairman of the House of Representatives Committee on Expenditures in the Executive Departments, embodied in H.R. 6670. This bill states in its title that it proposes to accelerate public construction in periods of business depression through the creation of an administration of public works, and that this agency will provide for a more effective coordination and correlation of the public works functions of the Government. The view prevailed that, with certain recommended amendments, the bill was probably the best starting point for the enactment of legislation of this character which could be secured at this time. President Hoover, in his Annual Message to Congress in December, recommended legislation along this line, and both the Democratic and Republican parties have endorsed the general principle of Government reorganization, of which this is an important part.

The Senate Joint Resolution 69, sponsored by Senator King, which would provide for the establishment of an inter-departmental Committee on Conservation of Natural Resources and for the cooperation with states in the conservation of natural resources, was looked upon with favor. However, the Assembly recorded itself to the effect that the objectives of this legislation could be better realized through the creation of an administration of public works.

The recommendations which the Public Affairs Committee made were adopted by the Assembly. The committee recommended:

1. That Council take no action, either opposing or favoring the Report of the Committee on Conservation and Administration of the Public Domain, as a whole; that it neither endorse nor condemn, as such, the general policies and special recommendations set up therein.

2. That Council direct its attention to each of the separate subjects listed below and specifically to bills introduced in Congress relating in whole or in part to these subjects, and support or oppose them as may be consistent with the policies already established or developed through the course of Council's previous activities in dealing with legislative matters of this kind.

a) Public policy

The problems of public policy arising out of the report are sufficiently important to warrant review from an engineering standpoint. The economic aspects of a proper national policy for the utilization of the public domain are of engineering concern.

b) Control of grazing land

Grazing lands should be placed under control and regulated and administered by a responsible agency and in a scientific manner. Range control, analogous to that of forest control, should be established.

c) Transfer of jurisdiction over public domain

The special recommendation of the Public Domain Committee, that of consolidating and coordinating the various bureaus and agencies that deal with the administration of the laws relating to the public domain, is thought to be a sound one and is of particular interest to American Engineering Council, in view of Council's sponsorship of a bill dealing with departmental reorganization.

d) Federal-aid roads

Road construction and maintenance are necessary on the unallotted and unreserved public domain chiefly in order to tie in the various highway systems. This, being largely an engineering problem, should be considered by the Council.

e) Water resources and control

(1) Erosion and resulting sedimentation
(2) Flood control
(3) Irrigation and drainage
(4) Water power
(5) Municipal water supply and sanitation
(6) Water transportation, rivers, harbors, and canals

f) Conservation of resources of the public domain

This includes the classification, reservation, and utilization of all land and water resources, such as minerals, power and reservoir sites, timber, and forage. The work involves a number of important engineering problems that justify its consideration by the Council.

g) Reclamation

Federal reclamation of arid lands should be continued but only when in accordance with sound agricultural economics.

3. That Council refer to its appropriate committees the foregoing subjects, to which this committee feels Council should give particular attention, with instructions that the several committees carefully study these phases of the report in preparation for appropriate action in connection with any legislation that may arise relating to them.

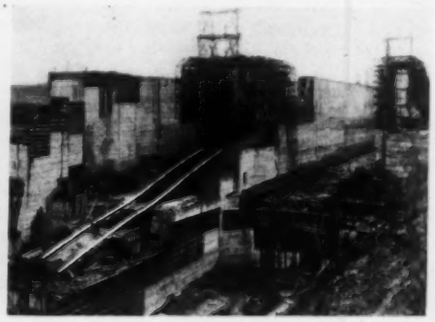
A Preview of Proceedings

The March issue of "Proceedings" will contain papers on three of the more spectacular types of construction with which civil engineers have to deal—bridges, inland waterways, and dams. These papers are concerned with the wind stresses in suspension bridges, the construction of the Welland Ship Canal across the Niagara Peninsula, the analytical and graphical methods of designing multiple-arch dams, and the value of hydro-electric power developments in the modern irrigation project. The annual report of the Board of Direction of the Society, abstracts from which are to be found elsewhere in this issue of "Civil Engineering," will appear in full in "Proceedings" for March.

SUSPENSION BRIDGES UNDER THE ACTION OF LATERAL FORCES

New ideas for determining the stresses caused by wind pressure in the stiffening trusses of suspension bridges are presented by L. S. Moisseiff, M. Am. Soc. C.E., and Frederick Lienhard. Two methods are explained; one by approximate uniform distribution of load; and the other, somewhat less simple, by what the authors call the elastic distribution method. The first, as its title suggests, is based on the assumption of uniform distribution of wind pressure on cables and trusses. According to the second, results are obtained by balancing the deflections of the two systems, cables and trusses. Although the treatment is mathematical, the description is simple.

Syphon Culvert and Canal Prism



Movable Forms in Lock No. 6

Bridge No. 14, Looking North

CONSTRUCTION OF THE WELLAND SHIP CANAL

This informative paper is quite short and decidedly readable.

The numberical example given is of a suspension bridge with a 4,000-ft. span. The methods are applied to the Manhattan Bridge, the Detroit River Bridge, the George Washington Bridge, the Delaware River Bridge, and to the hypothetical case of a suspension bridge with a span of 2,640 ft. Messrs. Moisseiff and Lienhard conclude that for spans up to 1,500 ft., with moderate live-load capacities, and for other spans up to 1,750 ft., with large live-load capacities, the horizontal moments in the trusses due to horizontal wind loads are practically the same whether computed by the approximate method or the more exact elastic distribution method. For unusually long spans, they recommend the latter. A significant conclusion drawn is that long-span suspension bridges are from two to four times as stiff in a lateral direction as simple spans and arches of the same width and chord area.

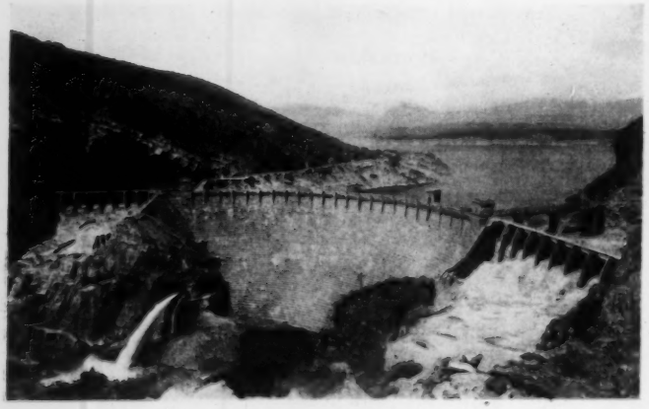
STRESSES IN INCLINED ARCHES OF MULTIPLE ARCH DAM

Analytical formulas for moments, thrust, and shear in the inclined circular arches of multiple arch dams are derived in a paper by George E. Goodall and Ivan M. Nelidov, both Associate Members Am. Soc. C.E. The authors have also computed and drawn the necessary computation curves so that the formulas may be solved graphically. In presenting this paper to members of the Society interested in the design of multiple arch dams, an effort has been made to include a reasonable number of these curves so that a clear idea may be gained of their great utility. It was not possible, however, to publish them all. For those who would find them useful in everyday work, a copy of the original manuscript with a complete set of the curves has been filed in the Engineering Societies Library, 33 West 39th Street, New York.

There are 17 diagrams in all, and if an order is placed with the Director of the Library, he will be glad to forward photostats of each of these diagrams at the nominal cost of 25 cents each, or $4.25, plus postage, for the entire set. Some of these curves are reproduced in their entirety in the paper; all the rest are reproduced in part to permit the solution of numerical examples.

All the equations were derived by integration, applying the theory of Castigliano, and they include the internal elastic work due to shear. In a brief appendix to the paper, the authors present an illustrative example demonstrating the application of their formulas and the use of the computation curves.

In their conclusion, they call attention to the effect of the non-uniform load—that is, variable water load and the weight of the arch—stating that it is of increasing importance as the arch span is increased. Especially is this true, according to Messrs. Goodall and Nelidov, in the upper part of the dam where the bending moments due to the non-uniform load are several times as large as those due to the uniform water load alone. Reinforcing steel



Roosevelt Dam, 25,000 Hp.

Mormon Flat Dam, 10,000 Hp.

POWER DEVELOPMENTS ON THE SALT RIVER, ARIZONA

is necessary in both faces of the arch, as shown by the fact that the sign of bending moments at a given section may be either positive or negative, and the arch should be reinforced for both conditions.

According to the authors, some multiple arches have been designed with reinforcing steel in one face of the arch only. It is expected designers will find that, by means of these formulas and the proposed diagrams, the labor of determining the stresses in the inclined arches of multiple arch dams will hereafter be reduced to a minimum. Discussion will be watched with interest.

CONSTRUCTION METHODS ON THE WELLAND SHIP CANAL

The paper by E. G. Cameron, Principal Assistant Engineer, Canadian Department of Railways and Canals, contains a brief sketch outlining the history of this project from the beginning of construction work in 1913. Mr. Cameron explains the reasons why the Canadian Government uses unit price contracts, dividing the work into large blocks aggregating $1,000,000 or more in value, and requiring a 5 per cent deposit on the total amount of each contract.

As in so many other cases, the World War interfered with progress on the construction of the canal but work was resumed again in 1919, first on a cost-plus basis, and finally, in 1921, on the original unit-price basis. The cost of the work is given as about $122,000,000.

Some interesting statistics supplied in detail are:

Earth excavation	50,000,000 cu. yd.
Rock excavation	9,000,000 cu. yd.
Concrete	3,500,000 cu. yd.

A generous display of cost data forms a most interesting part of Mr. Cameron's paper. Because the work extended over a period including pre-War and post-War prices, the opportunities for comparison are excellent.

HYDRO-ELECTRIC POWER DEVELOPMENT AS AN AID TO IRRIGATION

In the paper by C. C. Cragin, M. Am. Soc. C.E., arguments are presented to support the claim that hydro-electric developments in connection with some irrigation projects involve the same problems and the same limiting factors as any other hydro-electric development. A combined development, according to Mr. Cragin, introduces certain restricting considerations and these restrictions are explained in detail.

The problem is based on the fundamental assumption that a development is intended primarily for irrigation purposes and that power considerations are secondary. Hence Mr. Cragin concludes that: first, a power development must not interfere with the irrigation project; second, a margin of profit estimated from the sale of power should be much greater than in an ordinary hydro-electric development; third, if such a margin of profit is not available, power rights should be sold to produce power at the cost of steam or competing power; fourth, only in rare instances, and under favorable conditions, should power be retailed by promoters of an irrigation project; fifth, great benefits accrue to most projects from availability of power at a low increment of cost for drainage and supplemental irrigation pumping, or both; and sixth, a wide divergence exists between projects, some showing more benefits than others; but in general, benefits have overwhelmingly exceeded the disadvantages.

Examples to illustrate his points are drawn from experience in the construction of hydro-electric plants on the Salt River Project in Arizona.

ANNUAL REPORT OF THE BOARD OF DIRECTION

In compliance with the Constitution, the Board of Direction of the Society presents at the close of each year an annual report. The report for the year 1931, to be published complete in the March number of PROCEEDINGS, will show to the membership the present condition of the Society and its accomplishments during the past year. In it will be found a record of the work done by the Local Sections, the Technical Divisions, the Society's committees, and the Student Chapters; an analysis of publications; a résumé of the six Meetings; and a financial statement of receipts and expenditures, assets, and liabilities. The report is presented for the information of all members, in the hope that study of it will give a clear view of Society administration and accomplishments.

News of Local Sections

ALABAMA SECTION

At the annual business meeting of the Alabama Section the following officers were elected for the coming year: A. Clinton Decker, President; George J. Davis and Woolsey Finnell, Vice-Presidents; and W. N. Woodbury, Secretary-Treasurer.

ARIZONA SECTION

The seventh annual meeting of this Section took place on November 14. A business meeting was held at 9:30 A.M., at which the following officers were elected for the coming year: F. C. Kelton, President; R. A. Hoffman and G. L. McLane, Vice-Presidents; and E. V. Miller, Secretary-Treasurer. An enjoyable luncheon was followed by moving pictures and then a field demonstration of Petromuls hot rock mix construction and dust cure. A banquet and dance completed a very delightful day.

CHATTANOOGA SECTION

On December 21, the newly-organized Chattanooga Section held a meeting at which the following officers were elected for the coming year: W. H. Sears, President; O. J. Miller, First Vice-President; J. A. Fairleigh, Second Vice-President; and W. R. King, Secretary-Treasurer.

CINCINNATI SECTION

A joint meeting of this Section with the Student Chapter of the university was held on Friday, December 18. "The Essential Qualifications of a City Manager" was the subject discussed by C. A. Dykstra, City Manager; C. O. Sherrill, Former City Manager; H. M. Waite, Former City Manager of Dayton; and J. D. Ellis, Former Acting City Manager. A few short talks were later given by members of the Student Chapter on "What Is Necessary to Supplement the Education of the Engineer to Meet the Qualifications Requisite for a City Manager." Attendance at this meeting was 102.

CLEVELAND SECTION

A dinner meeting of the Cleveland Section was held on January 25 in honor of the former presidents of the Local Section. The speaker of the evening was Robert Hoffmann.

DAYTON SECTION

Officers for the coming year were elected at the December 14 meeting of this Section. The results of the election were as follows: C. S. Bennett, President; George F. Baker, First Vice-President; Robert B. Prinz, Second Vice-President; and John F. Hale, Secretary-Treasurer. The speaker of the day was Charles Kelso, who gave an interesting account of his recent trip to Africa.

The January meeting of this Section was addressed by H. E. Senf, who presented a moving picture showing the newly developed continuous process of making sheet steel at the plant of the American Rolling Mill Company at Middletown, Ohio.

DETROIT SECTION

The January meeting of the Detroit Section had two distinguished speakers—C. E. Myers, until recently Director of the Department of City Transit, Philadelphia, who spoke on "Prequalification and Arbitration of Public Works Contracts," and Grover C. Dillman, Commissioner of Highways, State of Michigan, who gave an address on "The Covert Road Law and Other Road Law Legislation." Both these addresses were greatly enjoyed by those present.

DISTRICT OF COLUMBIA SECTION

Guests of honor at the annual dinner meeting of this Section held in Washington on January 30, were Herbert S. Crocker, President, and George T. Seabury, Secretary of the Society. "Subways" was the subject of the talk given by Robert Ridgway, Chief Engineer, Board of Transportation, City of New York. Officers for the coming year were elected as follows: C. H. Birdseye, President; S. H. McCrory, Vice-President; and F. W. Amadon, Secretary-Treasurer.

FLORIDA SECTION

The following have been elected president and secretary of the Florida Section for the coming year: Robert M. Angas, President; and W. H. Goodloe, Secretary.

GEORGIA SECTION

The speaker of the day at the January meeting of the Georgia Section was James L. Mayson, City Attorney of Atlanta, who discussed the ethics and business of the engineering profession. Mr. Mayson's talk was thoroughly enjoyed by all present.

ILLINOIS SECTION

The Illinois Section elected Chester L. Post, President, and Fred G. Gordon, Secretary, for the coming year.

KANSAS STATE SECTION

The following have been elected president and secretary, respectively, of the Section for the coming year: W. C. McNown and F. W. Epps.

LEHIGH VALLEY SECTION

The Lehigh Valley Section has elected E. H. Rockwell, President, and M. O. Fuller, Secretary, for 1932.

MARYLAND SECTION

Baltimore was the scene of the annual meeting of the Maryland Section held on December 10. The following officers were elected to serve for the year 1932: Wilson T. Ballard, President; Gustav J. Requardt, Vice-President; and James W. Armstrong, Secretary-Treasurer. A very interesting and instructive paper was presented by W. N. Brown, Consulting Engineer of Washington, describing the topographic survey of the Upper Mississippi River and the application of aerial photography to such work.

In order to stimulate interest in local affairs, the Maryland Section offered a prize of $25 for the best paper to be written by one of its Junior Members during the year 1931. This prize has been awarded to Harry J. Engel, of Baltimore, who presented an excellent treatise on "Structural Features of Airplane Wing Design."

METROPOLITAN SECTION

At the regular monthly meeting of the Metropolitan Section, on February 17, the Port of New York was ably discussed by Maj. Billings Wilson, Assistant General Manager of the Port of New York Authority. He discussed the large number of agencies concerned with the development of the port, including the City of New York which built most of the steamship piers, the remainder having been constructed by private terminal companies and railroads. The Port Authority has concentrated on improving railroad terminal facilities and interstate highway connections and protecting the port from unfriendly rate attacks by outports.

The paper was discussed by Admiral Frederic R. Harris, Consulting Engineer; R. C. Morse, Assistant General Manager of the Pennsylvaia Railroad; and Theodore D. Pratt, General Manager of the Motor Truck Association of America. Following the discussion, Prof. Samuel I. Krieger, of the University of Göttingen, gave a demonstration of rapid calculating by use of his own formulas. He determined the logarithms of numbers, intricate roots, and fractional roots and powers of numbers more quickly than they could be handled by logarithms or slide-rules. The meeting closed with the usual refreshments.

NORTHWESTERN SECTION

A report from the Northwestern Section indicates that the joint meeting held on January 15, with the Student Chapter of the University of Minnesota, was most successful. The program, which was arranged and presented by the students, began with an illustrated talk by Russell Bennett, mining geologist of Minneapolis. Entertainment was then provided by Jack Tews, of the Student Chapter, who sang a number of ballads, accompanying himself on the guitar. W. C. Hill, president of the Student Chapter, spoke briefly in appreciation of the relation between the Section and the students, and the meeting closed with an amusing and impromptu skit directed by Tiny Stafford, student.

OKLAHOMA SECTION

At the meeting on December 11 of the Oklahoma Section the following officers were elected for the coming year: J. F. Brookes, President; E. S. Alderman, First Vice-President; V. H. Cochrane, Second Vice-President; and E. R. Stapley, Secretary-Treasurer. Honor awards, consisting of the payment of entrance fees for junior membership in the Society, were conferred upon Johnson L. Forbis, of the University of Oklahoma, and Dayton Williams, of the Oklahoma A. and M. College. This award is given annually to the most outstanding graduate from each of these two universities.

PHILADELPHIA SECTION

Approximately 190 members and guests attended the January meeting of the Philadelphia Section. "The Shop Fabrication of Steel" was the subject of the evening. In an introductory address, B. F. Hastings, District Engineer, American Institute of Steel Construction, emphasized the paramount importance of steel in modern structures. A very interesting address on the shop fabrication of steel was then made by C. A. Brown, District Manager, Pottstown Plant, McClintic-Marshall Corporation, in which were indicated some of the problems faced and solved by the fabricating shop; and J. A. Mitchell, Production Manager, Belmont Iron Works, spoke on the recent development of arc welding as applied to shop fabrication. Discussion was contributed by W. I. Lex, of the American Bridge Company; F. P. Witmer, Director, Civil Engineering Department, University of Pennsylvania; and J. G. Shryock, Chief Engineer, Belmont Iron Works.

PORTLAND (ORE.) SECTION

The Portland Section's annual meeting was held on Friday evening, January 8. The following officers were elected for the coming year: J. W. Cunningham, President; C. F. Thomas, Vice-President; G. H. Canfield, Secretary; and Geary Kimbrell, Treasurer. A very instructive and entertaining talk was then given by D. C. Henny, Vice-President of the Society, on the experiences and observations made during his recent trip to the East Indies and India. Attendance at this meeting was 49.

ROCHESTER SECTION

A lecture on reinforced concrete building construction delivered under the joint auspices of the Rochester Engineering Society, the Rochester Society of Architects, and the Rochester Section, was thoroughly enjoyed by all who attended the Ninth Annual Meeting of this Section held on January 7. During the business session the following were chosen officers for the coming year: Robert Buck Jeffers, President; Henry Lawrence Howe, First Vice-President; Carl Conrad Cooman, Second Vice-President; and Charles Frederick Starr, Secretary-Treasurer.

SACRAMENTO SECTION

The Sacramento Section's weekly meetings have been very well attended. The speakers at these various meetings were B. M. Woods, of the University of California, who addressed one of the gatherings on "Recent Developments in Aeronautics"; Lyman D. Wilbur, who recently returned from two years service in Russia and addressed a meeting on "Russia"; and Jack Carbannis, automotive engineer, who spoke on "Improvements Made in Automobile Design."

The Annual Jinks meeting was held on December 22. "Recent Developments in Measuring Irrigation Water" was the subject of a paper read on January 5 by J. E. Christiansen.

Election for 1932 officers was held on January 12 and resulted as follows: Fred J. Grumm, President; Carl Maughmer, First Vice-President; C. H. Kromer, Second Vice-President; and Norwood Silsbee, Secretary.

There were 112 members and guests in attendance at the annual dinner, installation of officers, and dance held on January 21.

SAN DIEGO SECTION

At the last regular meeting of this Section held on December 17, the following officers were elected: Charles P. Williams, President; R. R. Rowe, Vice-President; and P. Beermann, Secretary-Treasurer.

SEATTLE SECTION

The regular monthly meeting of the Seattle Section was held on January 5, and the following officers were elected: O. A. Piper,

President; M. O. Sylliaasen, Vice-President; and Thomas D. Hunt, Secretary-Treasurer. After the business meeting, D. W. McMorris, City Engineer of the City of Seattle, and O. A. Piper, Assistant City Engineer, gave very interesting accounts of the contemplated improvements to be made by Seattle during the year 1932.

SPOKANE SECTION

A noon meeting of this Section was held on January 8, at which the following officers were elected for the coming year: Victor H. Greisser, President; B. J. Garnett, First Vice-President; Ivan C. Crawford, Second Vice-President; and J. Walter Robinson, Secretary-Treasurer. "The Accomplishments and Future Plans of the Spokane City Plan Commission" was the subject of a very interesting discussion by B. H. Keyser, attorney and president of the commission.

ST. LOUIS SECTION

There were 40 in attendance at the regular monthly luncheon meeting of this Section, held on Monday, January 25. A very interesting account of the working conditions at the Hoover Dam was given by Baxter L. Brown.

SYRACUSE SECTION

The Syracuse Section held a dinner meeting on Monday evening, January 11. The guest of the Section, Elwood Mead, Commissioner of Reclamation, U.S. Department of the Interior, Washington, D.C., briefly described the work of the Reclamation Service.

SAN FRANCISCO SECTION

The San Francisco Section has elected George W. Pracy president, and Harold B. Hammill secretary, for the coming year.

Student Chapter News

COLLEGE OF THE CITY OF NEW YORK STUDENT CHAPTER

Senior members of the College of the City of New York Student Chapter were privileged to accompany members of the Society on a tour of the notable bridges in the vicinity of New York, made as part of the program of the Annual Meeting. Among the structures visited on this interesting excursion were the George Washington Memorial Bridge over the Hudson; the Goethals Bridge and the Bayonne Arch, recent projects of the Port of New York Authority; and the Hackensack River span and its twin bridge over the Passaic River, now under construction.

BAYONNE BRIDGE—PIN 18 IN. IN DIAMETER

To gain more detailed information the Student Chapter later revisited some of these structures. Through the courtesy of Col. H. W. Hudson, they made a thorough inspection of the Hackensack and Passaic River projects. This trip was conducted by R. S. Dubois, of the New Jersey Highway Commission, and Prof. J. Charles Rathbun. Visits to structures erected by the Port of New York Authority were supervised by A. B. Piver of that organization.

UNIVERSITY OF CALIFORNIA STUDENT CHAPTER

During the past winter the Student Chapter of the University of California has had a number of interesting meetings. The first meeting was held on September 3, when Prof. G. E. Beggs of Princeton University gave an illustrated lecture on "The Use of Models in Bridge Design."

Moving pictures of "The Spinning of the Cables of the George Washington Bridge" were shown through the courtesy of the Roebling Company on October 13; and the speaker of the evening at the November meeting was L. W. Wyman, of the California Corrugated Culvert Company of Berkeley, who gave an interesting talk on the development and use of culverts, together with illustrations of modern design. Guests at the last meeting of the semester were Mr. Thomas of Stanford University, president of the Student Chapter, and L. B. Reynolds, president of the San Francisco Section. Professor Reynolds gave an interesting talk on the activities of the Society, the Section, and the Chapter.

The following officers have been elected for the spring semester: Edward J. Reese, President; Jerrold M. Gayner, Vice-President; Richard A. Hayler, Secretary; and Edgar Garbarini, Treasurer.

UNIVERSITY OF COLORADO STUDENT CHAPTER

Fortnightly meetings are being held by the University of Colorado Student Chapter during the current year. Many subjects of engineering importance are discussed at these meetings, both by students and outside members of the profession. Included in the wide range of topics considered have been such timely subjects as "Water Resources of Colorado," "The Proposed Golden Gate Bridge at San Francisco," and "The Location, Design, and Construction of Airports."

UNIVERSITY OF ILLINOIS STUDENT CHAPTER

After the summer vacation, activities of the University of Illinois Student Chapter were resumed with a smoker on September 25. On that occasion Professor Knight, of the Electrical Engineering Department, demonstrated some of the many wonderful things which can be accomplished by the use of lights and shadows.

At the first regular meeting, D. B. Steinman, of Robinson and Steinman, consulting engineers in New York City, gave a very interesting illustrated lecture on "Fifty Years of Bridge Building." At the next meeting, October 13, Lytle Brown, Chief of Engineers, U.S. Army, spoke on "National Security."

On October 20, L. D. Gayton, City Engineer of Chicago, gave a very interesting talk on "Chicago's Bridges," and on November 5, H. M. Westergaard, consultant on the Hoover Dam, gave an illustrated lecture on the Boulder Canyon dam development.

STUDENT CHAPTER OF THE COLLEGE OF THE CITY OF NEW YORK AT THE GEORGE WASHINGTON BRIDGE

A comprehensive review of the details involved in the fabrication of structural steel was given by Mr. Reichmann, of the American Bridge Company, on November 17. Slides were shown covering all of the processes in the fabrication shop.

At the meeting on December 2, Carol Aronovici, City Planner of Los Angeles, spoke on the "Community Plan and the Sciences." An illustrated lecture on "Waterways" was given on December 15 by T. Q. Ashburn, Chairman of the Inland Waterways Corporation.

At the last meeting, Robert H. Ford, Assistant Chief Engineer for the Chicago, Rock Island, and Pacific Railroad, spoke on "Recent Tendencies in Transportation."

ITEMS OF INTEREST

Engineering Events in Brief

Civil Engineering for April

FOR SEVERAL years the attention of bridge engineers has been focused on the great steel arch bridge spanning Sydney Harbor, Australia, that is soon to be completed and opened for traffic. Assurance has been received from Ralph Freeman, M. Am. Soc. C.E., that his article on the Sydney Harbor Bridge will be ready in time for the April issue of CIVIL ENGINEERING. He will describe the main engineering features of the bridge and compare it in design and construction with the Hell Gate Arch, New York, built in 1916. The 977½-ft. span of the latter structure, of unprecedented length at the time of its construction, is 670 ft. less than that of the Sydney Harbor Bridge.

An article on "Designing Tunneled Sewers in Heavy Ground" has been prepared by Robert G. Hennes, Jun. Am. Soc. C.E., also for the April issue. It gives in diagrammatic form data for the design of arch rings in different types of soil and at various depths, to withstand both bending stresses and direct compression. The design diagrams are based upon recent soil studies and rational theory, but mathematical formulas are not given. The author emphasizes the difference between work in open cut, in tunnel, and in various types of soils.

Twenty-five concrete dams in Scandinavia have been studied recently by Oren Reed, Assoc. M. Am. Soc. C.E. These dams are subject to severe weather conditions—some of them are north of the Arctic Circle—and to abrasion from logs and ice jams. For these reasons as well as because of percolating water, they are inspected annually. Many of these masonry and concrete structures are now in need of extensive repair. Measurements of the quantity and mineral content of the leakage at one dam showed that the 8,000 acre-ft. of water which percolated through the structure in 1928 carried away 30 tons of material from the body of the structure.

In the course of studies to solve the flood control problems of Salina, Kans., careful measurements were made on the Smoky Hill River at the peak of one of its floods. Fortunately, accurate cross sections had been previously taken. By means of these and the velocities determined by current meter at two stations, some basic roughness coefficients have been calculated that will be of value to hydraulic engineers faced with the problem of estimating such coefficients for streams similarly obstructed. Measurements and calculations were made by R. J. Paulette, M. Am. Soc. C.E., City Engineer of Salina, assisted by W. C. Wiggin.

Another interesting feature planned for the April issue is an article on the "Economic and Engineering Aspects of Wood Preservation," by Ralph H. Mann, Assoc. M. Am. Soc. C.E. It deals with the period of service of timber structures and the extent to which that period can be extended by the use of various preservatives applied as a coating or by impregnation. Although wood was first treated in an experimental way in the United States as early as 1856, the high cost of chemicals and the abundance of timber made its application uneconomical until about 1875. By 1904, thirty-three treatment plants were in operation; and by 1929 this number had increased to 156 plants, treating in that year 4,344 million board-feet of lumber.

Results of Welding Studies Published

IN ORDER TO determine the stresses that can be used with safety in the design of welded steel structures fabricated under ordinary shop conditions, the Structural Steel Welding Committee of the American Bureau of Welding has conducted a comprehensive series of tests over a period of five years. The results of these tests and other information obtained from its studies have now been published as the report of that committee.

In view of the growing interest of civil engineers in the subject of welding, this carefully compiled report should prove of great practical value to the profession. It may be purchased for one dollar on application to the Secretary of the Bureau of Welding, 29 West 39th Street, New York. For quantities of ten or more, the price is 75 cents each.

Sanitation Projects Advocated for Alleviating Unemployment

THE CONFERENCE of State Sanitary Engineers includes the chief engineers of the health departments of the states. Last September it created a Committee on Sanitation Projects for Unemployment Relief, which during October and November 1931, gathered data from 43 states having an aggregate population of 113,000,000. The committee issued a report to the public health authorities of the United States, from which the following brief abstract of certain items of interest to civil engineers has been compiled by W. L. Stevenson, M. Am. Soc. C.E., chairman of the committee.

"Part of the funds now being provided for unemployment relief obviously will be needed for food, clothing, fuel, and shelter for some unemployed and their dependents, but a goodly share of these funds should and undoubtedly will be expended toward providing opportunities for the able bodied to work and thus take care of their families. Such work, so far as possible, should be of permanent value and not ephemeral. Sanitary engineering projects surely fall within this preferred class.

"Notwithstanding that at least 60,000,000 people in the United States are furnished purified water supplies, that most cities and towns generally provide sewerage facilities, and that a campaign has been carried on toward the elimination of malaria-transmitting mosquitoes; the fact remains that there are still many communities in the United States that need to carry out sanitary engineering projects for improving environment.

"The data collected by the committee during the latter part of 1931 showed that sanitary engineering projects were generally curtailed in 24 states with a population of 62,000,000, and proceeding as usual in 18 states having 51,000,000 population.

"In the opinion of the committee, work for unemployed can be created by state governments carrying out a variety of sanitary engineering projects. Pure drinking water should be supplied to all occupied buildings owned or controlled by the states. Sewage and industrial wastes produced at state owned or controlled buildings should be properly treated to prevent harmful stream pollution. In parts of the country where malaria is prevalent, land owned or controlled by the states, and in such a condition that malaria-carrying mosquitoes may breed on it and create a menace to the public health, should be so controlled by filling in, oiling, and draining as to abate the malaria menace. In addition, occupied buildings owned or controlled by the state and subject to the invasion of malaria-carrying mosquitoes should be thoroughly screened.

"The branches of the various state governments having by law jurisdiction over these and other matters involving the sanitary environment of man should exercise their lawful powers, with justice and equity, to require the prosecution of work by municipalities which will result in real protection to the public health and produce work for the unemployed, where and when the need for it exists and there is local ability to comply with the order.

"It is of the utmost importance in these days of decreased municipal income from taxes that when it becomes necessary to reduce appropriations, the force in charge of the operation of water works and sewage treatment works shall not be reduced to an extent that will in any way endanger the purity of public water supplies or permit an inferior quality of sewage effluent to menace any source of public

supply derived from lower down on the stream.

"With the prevailing low prices of materials of construction and the urgent need of work for the unemployed, now is the time for municipalities to engage in the construction of public works of permanent value, and especially those which will serve to safeguard health.

"To do these things generally requires funds provided by bond issues. It should be borne in mind that after authorization, such moneys are at once available upon sale of the bonds, and that a dollar spent today will accomplish more than in past years and, it is hoped and expected, more than in the future. Money so spent now will help give employment to those who, lacking it, will be a drain on other funds provided for the sustenance of the unemployed and their dependents. Where possible, a competent engineer familiar with construction work should serve on every unemployment committee so that he can advise his colleagues on engineering projects.

"According to the latest reports available to the committee, many state health departments have been diligent in their efforts to hasten the accomplishment of sanitary engineering projects, as recommended in the report."

Research Assistantships Available

It is announced by the Director of the Engineering Experiment Station of the University of Illinois that applications for appointment to graduate research assistantships should be received not later than April 1, 1932. His announcement states, in part:

"To assist in the conduct of engineering research and to extend and strengthen the field of its graduate work in engineering, the University of Illinois maintains 14 Research Graduate Assistantships in the Engineering Experiment Station. Two other such assistantships have been established under the patronage of the Illinois Gas Association. These assistantships, for each of which there is an annual stipend of $600 and freedom from all fees except the matriculation and diploma fees, are open to graduates of approved American and foreign universities and technical schools.... Research work and graduate study may be undertaken in architecture, architectural engineering, ceramic engineering, chemistry, civil engineering, electrical engineering, mechanical engineering, mining engineering, municipal and sanitary engineering, physics, railway engineering, and theoretical and applied mechanics."

Further information regarding these assistantships may be had from M. S. Ketchum, Dean of the College of Engineering and Director of the Engineering Experiment Station, Urbana, Ill.

NEWS OF ENGINEERS

From Correspondence and Society Files

ARTHUR JOHNSON, Assistant Engineer in the Power Division, Conservation Branch, U.S. Geological Survey, in Washington, was previously Assistant Engineer in the Water Resources Branch of the U.S. Geological Survey.

R. F. BUCK has accepted a position with the Eastern Saturmix Company in Upper Darby, Pa. He was formerly Construction Manager for the Union Paving Company in Philadelphia.

LAWRENCE G. LENHARDT, heretofore Assistant Engineer, Department of Water Supply, Detroit, Mich., is now Commissioner, Department of Public Works, Detroit.

HAROLD W. BAKER, former Commissioner of Public Works in Rochester, N.Y., has moved to Washington, where he is Director of Construction for the District of Columbia.

ADOLPH J. ACKERMAN, formerly Hydraulic Designing Engineer with the Aluminum Company of America, is now in St. Louis as Structural Engineer for the W. E. Callahan Construction Company and Peterson, Shirley, and Gunther, Contractors on the Madden Dam Project, Canal Zone.

H. E. HOWES has been transferred from Charleston, S.C., where he has been Hydro-Electric Engineer in the U.S. Engineer Office, to the Portland, Ore., office of the Forest Service, where he will be Assistant Regional Engineer.

J. G. ROLLINS, formerly of Austin, Tex., is now in San Antonio where he is taking over the San Antonio Division for the State Highway Department.

WALTER F. LINEBERGER, Assistant to the President of the Standard Dredging Company in New York City, formerly was Vice-President of the Airways Corporation of America, in Washington, D.C.

FRED COFFMAN is now Assistant Engineer for the North Carolina State Board of Health.

JOHN S. HAZELTON, of St. Louis, Mo., previously connected with Winston Brothers Company of that city, is now Bridge Inspector in the Bridge Department of the Missouri Pacific Railroad.

LEONARD E. OTT, Assistant Superintendent, Merritt-Chapman, and Whitney Corporation, U.S. Lock and Dam No. 15, in Rock Island, Ill., was at one time Superintendent of A. Guthrie and Company, Inc., in St. Paul.

R. A. WILLIS is no longer connected with the Portland Cement Association in St. Louis, but is now engaged in doing research work for the City Plan Commission of that city.

CHARLES J. ZUSI, former Director of Research, Atlas Plywood Corporation, in Lawrence, Mass., is now Research Engineer for the Hinde and Dauch Paper Company of Canada.

S. EARLE KING, since January 1, has been Chief Civil Engineer of the General Engineering Company in Wilmington, Del.

FRANCIS H. PHIPPS, Division Engineer, Department of City Planning, New York City, was formerly Assistant Engineer, Tunnel Division, Board of Transportation in the same city.

WALTER S. MCDONALD has been elected President of Sterling Associates in Atlanta, Ga. Previously, Mr. McDonald was Secretary-Treasurer of McDonald and Company, Engineers and Architects, Atlanta.

G. R. STRANDBERG has recently been promoted from the position of Assistant to Chief Hydraulic Engineer to that of Project Engineer for the Stone and Webster Engineering Corporation in Boston.

T. L. WARDEN, District Engineer for the Portland Cement Association in Dallas, Tex., was prior to this Engineering Manager of the Gulf Coast Good Roads Association in Houston.

A. R. LOSH, former City Manager of Oklahoma City, is Manager of the Asphalt and Road Oil Division of the Anderson-Prichard Corporation in Oklahoma City.

THOMAS E. COLLINS, City Engineer of Elizabeth, N.J., has been appointed also Chief Engineer of the newly created Municipal Water Department of Elizabeth.

B. B. LEWIS, connected at one time with the United Fruit Company in Guatemala, as Chief Engineer, is now Chief Engineer for the International Railways of Central America in Guatemala City.

JEPTHA A. WADE, Assistant to Chief Engineer, Federal Water Service Corporation in New York City, was formerly connected with the Public Works Engineering Corporation of this city.

RICHARD D. FIELD is in Augusta, Me., where he has accepted a position as Junior Engineer in the Bridge Department of the Maine State Highway Commission.

PAUL C. CAMPBELL, previously connected with Ulen and Company in Lebanon, Ind., is now with Northwest Precote, Inc., in Seattle, Wash.

JAMES G. TRIPP, whose residence has been in Los Angeles, has accepted a position with the Merritt-Chapman and Whitney Corporation, in Rock Island, Ill.

RICHARD B. SHEPARD, JR., now connected with the Commonwealth and Southern Corporation in Alabama, was formerly in the Engineering Department of the Alabama Power Company.

BRUCE D. GREENSHIELDS, previously Acting Professor of Civil Engineering, has been appointed Professor of Engineering Science at Denison University in Granville, Ohio.

HOWARD DORISS, former Western Representative for Francisco and Jacobus

in Los Angeles, is now connected with the New York Dock Company in New York City.

J. W. B. BLACKMAN, who has recently been appointed President of the Pan-Pacific Piling and Construction Company in Wilmington, Calif., was formerly a consulting engineer in Long Beach, Calif.

CLAUDE HALE BIRDSEYE has been appointed Assistant to the Director, U.S. Geological Survey, Washington, D.C.

BOYD A. BENNETT, previously connected with the Public Works Engineering Corporation in New York City, is now with the New York Water Service Corporation.

J. C. ENGLEHART, affiliated with the Architectural Division, Department of Public Works, State of New York, was previously connected with the Taylor-Fichter Steel Construction Company, Inc., in New York City.

MARSHALL WILLIAMS has been appointed Assistant to the President of the American Bridge Company, with offices in the Frick Building, Pittsburgh. Formerly Mr. Williams was Assistant General Operating Manager of this company.

LOUIS LAY CALVERT, who has been Assistant Structural Engineer for United Engineers and Constructors, Inc., in Philadelphia, is now associated with Construction Service, Veterans Administration, Washington, D.C.

H. L. HANDLEY, a former resident of Rains, Utah, is now Resident Engineer for the U.S. Bureau of Public Roads, Hawaii National Park, Hawaii, T.H.

G. A. AMBERG has moved from Cairo, Ill., to Memphis, Tenn., where he is employed in the U.S. Engineer Office as Associate Engineer in charge of Levee Operations Division.

D. S. BRIGHT, District Sales Manager for the Concrete Steel Company, has been transferred to the Washington, D.C., office of this company.

NORMAN F. BROWN, who has opened offices in Pittsburgh, as a consulting engineer, was prior to this Director of the Department of Public Works, Allegheny County, with offices in Pittsburgh.

H. J. CAULFIELD has been Chief Concrete Inspector for Wharton County, Texas, since May 1931, on an extensive paving program. Previously Mr. Caulfield was Division Resident Engineer for the State Highway Department in Houston.

NELS P. NELSON, former Division Engineer for the Chicago, Burlington, and Quincy Railroad in Casper, Wyo., is now in McLean, Tex., at Engineers' Camp 6, Le Fors Route.

J. L. EDWARDS, L. R. HJORTH, A. J. WILCOX, and G. A. SALLANS who for many years were associated with H. G. Balcom, Consulting Engineer, in New York City, have now joined the firm as associate partners.

J. EDWARD POWELL, formerly connected with the New York Central Railroad in New York City as Designer and Detailer, is now with Gibbs and Hill, Consulting Engineers, also in New York City.

CHARLES V. WITT, Chief Engineer and General Manager of the Steel Watermains Association, Inc., in Greensburg, Pa., was previously President of the Witt Steel Company in Greensburg.

A. F. FISCHER, at present with the Iowa Culvert and Pipe Company, was previously Manager of the Independence Corrugated Culvert Company of Mason City, Iowa.

GLENN L. ENKE since September has been an Assistant Bridge Designing Engineer for the Highway Division of the Department of Public Works, State of California.

ARTHUR H. CASTELAZO is now in Sacramento, Calif., where he is employed by the State Department of Public Works Division of Highways as Junior Bridge Designing Engineer.

DOUGLAS C. SEELEY is now employed in the U.S. Department of the Interior, Bureau of Reclamations, Denver, Colo. Before accepting this new connection, Mr. Seeley was Sanitary Inspector, State Department of Health, Pittsburgh.

FRANKLIN O. ROSE, Assistant Professor of Mechanical Engineering at the University of California, was formerly instructor in engineering and mathematics at the Modesto Junior College, in Modesto, Calif.

F. J. NEBIKER, a former resident of Everglades, Fla., where he was Office Engineer in Charge, Florida Development Company, is now in Jacksonville where he is connected with the Okeechobee Flood Control District.

HUNG H. LING, Director and Engineer in Chief, Tungkwan-Sianfu Section Lunghai Railway, was formerly Director of the Bureau of Construction, Lunghai Railway, Chengchow, Honan, China.

G. E. GOODALL, Senior Engineer of Hydraulic Structure Design, Division of Water Resources, California State Department of Public Works, was formerly Associate Hydraulic Engineer, Division of Dams.

C. A. HARRELL is leaving Portsmouth, Ohio, where he has been city manager, in order to fill a similar position in Binghamton, N.Y.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From January 9 to February 9, 1932

ADDITIONS TO MEMBERSHIP

ANDERSON, JAMES PENNELL (M. '31), Div. Engr., N.C. & St. L. Ry., Box 892, Atlanta, Ga.

ATWOOD, GILBERT HUMPHREY (Assoc. M. '31), Asst. Engr., Vice-Pres., and Secy., C. W. Hudson, Inc., 15 Park Row, New York (Res., 200 Lincoln Pl., Brooklyn), N.Y.

BAMBEY, JOHN WILLIAM (Jun. '32), Rodman, N.Y.C.R. (Res., 42 Bedford Park Boulevard), New York, N.Y.

BAUER, CHARLES HENRY, JR. (Jun. '32), Draftsman, Guilbert & Betelle, Newark (Res., 615 North Grove St., East Orange), N.J.

BOARD, ALBERT FRENCH, JR. (Jun. '31), with Corps of Engrs., U.S.A., U.S. Engr. Office, London, W.Va.

BOARD, LEONARD MARVIN (Jun. '31), San. Engr., Monongalia County Health Dept. (Res., 46 Jones Ave.), Morgantown, W.Va.

BOWHAY, ALFRED V. (Assoc. M. '32), Asst. Engr., City Engr. Office, care, City Engr., Room 368, City Hall, San Francisco, Calif.

BRIGGS, MILTON ALVER (Jun. '31), 1200 Main St., Bradley Beach, N.J.

BROWNFIELD, ALLEN HARRY (Jun. '32), Junior Constr. Engr., Bridges, Grade III, State Div. of Highways (Res., 1248 Fifth Ave.), San Francisco, Calif.

BUCK, ROBINSON DUDLEY (Jun. '31), 293 Oxford St., Hartford, Conn.

CAMPBELL, MAXWELTAN SELWYN (Jun. '31), Box 303, Graduate Club, Chapel Hill, N.C.

COONS, ALFRED DEVORE (Jun. '31), Res. Engr., Univ. of California, Branch Coll. of Agriculture, University Farm, Davis, Calif.

DAVIS, KENNETH HOWE (Assoc. M. '31), Chf. Engr., Western Steel & Wire Co., Ltd., 439 Bryant St., San Francisco, Calif.

DEBERARD, EMMONS WILFORD (Jun. '31), 220 Garfield Ave., Kansas City, Mo.

DINKLAGE, WILLIAM KENNETH (Assoc. M. '32), Div. Constr. Engr., State Highway Comm. (Res., 1219 Grand Ave.), Topeka, Kans.

DOHRENWEND, CLAYTON OLIVER (Jun. '31), 139 Lincoln St., New Britain, Conn.

ELLIOTT, GEORGE RAY (Assoc. M. '31), Constr. Engr., Alfes-Elliott Co., 4628 Moran St. (Res., 4280 Sixth St., Ecorse), Detroit, Mich.

EMERY, HOWARD IVAN (Jun. '31), 2258 Ocean Ave., Brooklyn, N.Y.

ERLANDSEN, OSCAR, JR. (Jun. '31), 175-19 Devonshire Rd., Jamaica, N.Y.

FISCEL, LOUIS O'NIEL (Jun. '31), County Engr., Pinal County Highway Dept., Box 473, Florence, Ariz.

GEORGE, PRESTON WILLIAM (Jun. '31), Insp., State Dept. of Highways, Box 241, Lawton, Okla.

GRANT, FREDERICK NICKERSON (Assoc. M. '31), Dist. Engr., State Highway Dept., Phoenix, Ariz.

GUARD, CARL JACKSON (Jun. '31), 509 South Lake St., Orlando, Fla.

GUNDERSEN, THOMAS CHRISTIAN (Jun. '31), Lakeview, Wash.

HARROUN, DALE THERAN (Jun. '32), 3530 Alameda Drive, Toledo, Ohio.

HENDERSON, ERNEST RAY (Jun. '31), Grapeland, Tex.

HERTZ, ALBERT LESLIE (Assoc. M. '31), Junior Engr., Southern Dist., Municipal Eng. Div., Panama Canal, Balboa, Canal Zone.

HYLLAND, EINAR NYSOM (Jun. '31), Designer, Beauharnois Constr. Co., Box 50, Beauharnois, Que., Canada.

IANDOLO, JEREMIAH CONSTANTINE (Jun. '31), 1545 West Passyunk Ave., Philadelphia, Pa.

INGERSON, IRVIN MILTON (Assoc. M. '31), 4801 Ninth Ave., Sacramento, Calif.

JAYASWAL, UMESH SINGH (Assoc. M. '31), Dist. Engr., B. & N. W. Ry., Muzaffarpur (B and O), India.

KIELY, JOHN ROCHE (Jun. '31), 1104 North Steel St., Tacoma, Wash.

KOEHLER, ALFRED FREDERICK (Jun. '31), 2332 Walton Ave., New York, N.Y.

KUHL, OTTO ERNST (Jun. '31), 50 Euclid Ave., Troy, N.Y.

LARSON, GEORGE THEODORE (Assoc. M. '32), Constr. Engr., Long Island State Road Comm. (Res., 47 Hewlett Court), Babylon, N.Y.

LEVANDER, CARL GUSTAF (Assoc. M. '31), Sewer Engr., City of Austin, 4314 Ave. F, Austin, Tex.

LOSEE, MILTON GILBERT (Assoc. M. '31), Estimator, George P. Reintjes Co., 3032 East 6th St., Kansas City, Mo.

LOWE, CLAYTON REEVES (Jun. '31), care, State Highway Comm., Zwolle, La.

LYSE, ALVIN THEODORE (Assoc. M. '31), Sales Engr., Spokane Culvert & Tank Co. (Res., 4019 Fifteenth Ave., N.E.), Seattle, Wash.

MAULSBY, DAVID LEE (Jun. '31), Asst. Supt. of Coupling Shop, The Bartlett Hayward Co. (Res., 1624 Eutaw Pl.), Baltimore, Md.

MEYER, NATHAN (Assoc. M. '31), 2802 Ave. K, Brooklyn, N.Y.

MICHAUD, HENRY EUGENE (Assoc. M. '31), with C. & O. Ry. (Res., 76 Chittenden Ave.), Columbus, Ohio.

MILLER, FRANK WAYLAND (Jun. '31), care, U.S. Constr. Engrs., 433 West Harrison St., Chicago, Ill.

MINDLIN, RAYMOND DAVID (Jun. '32), John Jay Hall, Columbia Univ., New York, N.Y.

MINETTI, RICHARD LASALLE (Jun. '31), 58 Lincoln Pl., Brooklyn, N.Y.

MOSHER, EDGAR DANIEL (Jun. '32), Instr., Civ. Eng. Dept., Univ. of Pittsburgh, 202 Thaw Hall, Univ. of Pittsburgh, Pittsburgh, Pa.

NEWELL, MAXWELL ATKINSON (Assoc. M. Dec. '31), Mgr., Irrig. Dept., R. Hardesty Mfg. Co., Denver, Colo.

O'CONNELL, CONRAD WILLIAM (Assoc. M. '31), Chf. Engr., The Foundation Co., Casilla 190, Oruro, Bolivia.

OLMSTED, ARTHUR GEORGE (Jun. '32), Student Engr., U.S. Engr. Office, Huntington, W.Va.

PLETTA, DAN HENRY (Jun. '32), Asst. Prof., Civ. Eng., Univ. of South Dakota (Res., 208 North Pine St.), Vermilion, S.D.

RUBINOWITZ, ISIDORE (Jun. '32), Structural Draftsman, Board of Transportation, New York (Res., 311 Utica Ave., Brooklyn), N.Y.

RYLAND, EMOS WILLIAM (Jun. '31), Junior Engr., U.S. Bureau of Reclamation (Res., 1933 Sherman St.), Denver, Colo.

SNAVELY, HARRY GREIDER (Jun. '31), Rohrerstown, Pa.

TANGEMAN, RICHARD MICHAL (Jun. '31), care, W. L. Johnson Constr. Co., Defiance, Ohio.

TEAZE, MOSES HAY (M. Jan. '32), Cons. Engr., (Hardy S. Ferguson & Co.), New York, N.Y. (Res., 31 Clarendon Pl., Bloomfield, N.J.)

TRUE, JAMES NORVEL (Jun. '31), care, E. L. Simons, Antioch, Ill.

VANDERLIP, ARTHUR NELSON (Jun. '31), Archt's Representative, Voorhees, Gmelin & Walker, New York (Res., 225 Ridgedale Rd., Ithaca), N.Y.

WILLIAMS, HARRY ANDREW (Assoc. M. '32), Teaching Asst., Stanford Univ., Box 1951, Stanford University, Calif.

WRIGHT, CHARLES PENZEL (Assoc. M. '31), Field Engr., Phoenix Utility Co., Hot Springs (Res., 3518 Hill Rd., Little Rock), Ark.

MEMBERSHIP TRANSFERS

BLACKWOOD, EDWIN NEALE (Jun. '28; Assoc. M. '31), County Road Engr., Kanawha County (Res., 1618 Virginia St.), Charleston, W.Va.

BROWN, MARVIN SANGER (Jun. '28; Assoc. M. '32), Vice-Pres. and Asst. Engr., The Wendell P. Brown Co., 750 Prospect Ave., Cleveland, Ohio.

BUNGER, HOWARD PHELPS (Assoc. M. '28; M. '31), Designing Engr., The J. G. White Eng. Corporation S. en C., 2a San Juan de Letran 24, City of Mexico, Mexico.

BUTLER, MILLARD ANGLE (Assoc. M. '11; M. '31), Cons. Engr., Ulen & Co., 120 Broadway, New York, N.Y. (Res., 703 Graydon Ave., Norfolk, Va.)

CLAUSEN, CHESTER KESSLER (Jun. '26; Assoc. M. '31), Structural Draftsman and Designer, C. M. St. P. & P. R.R., 618 White Bldg. (Res., 1626 Thirty-Third Ave.), Seattle, Wash.

COX, WILLIAM JUNKIN (Jun. '19; Assoc. M. '27; M. '32), Asst. Prof., Eng. Mechanics, Sheffield Scientific School, Yale Univ., 51 Prospect St., New Haven, Conn.

EDDY, BEN A. (Assoc. M. '29; M. '32), Locating Engr., Met. Water Dist. of Southern California, Beaumont, Calif.

EPSTEIN, ALEXANDER (Jun. '28; Assoc. M. '31), Field Draftsman, State Highway Dept., Ehrhardt, S.C.

FINEBAUM, HENRY JACOB (Assoc. M. '19; M. '32), Cons. Engr., 18 East 48th St. (Res., 41 West 96th St.), New York, N.Y.

JOLLEY, HAROLD DEAN (Assoc. M. '19; M. '32), Vice-Pres. and Chf. Engr., Concrete Eng. Co., 1141 North 11th St., Omaha, Nebr.

MCGEHEE, CHARLES BURNAM (Jun. '26; Assoc. M. '32), Dist. Mgr., Truscon Steel Co., 610 Rhodes-Haverty Bldg., Atlanta, Ga.

MCGOWAN, MATTHEW BERNARD, JR. (Jun. '26; Assoc. M. '32), Civ. Engr., M. B. McGowan, 617 Call Bldg., San Francisco, Calif.

MEYER, LESTER LOUIS (Jun. '26; Assoc. M. '32), Asst. Civ. Engr., Bureau of Water Works and Supply, 207 South Broadway (Res., 351 North Orange Drive), Los Angeles, Calif.

MORTON, PAUL STEELE (Assoc. M. '28; M. '32), City Mgr., City Hall, Lexington, Ky.

POWELL, RALPH WATERBURY (Assoc. M. '28; M. '32), Asst. Prof. of Mechanics, Ohio State Univ. (Res., 75 West Norwich Ave.), Columbus, Ohio.

RICKARD, GROVER EDGAR (Assoc. M. '27; M. Jan. '32), Chemist, Wheeling Filtration Plant (Res., 108 North 20th St.), Wheeling, W.Va.

ROWE, RALPH ROBINSON (Assoc. M. '27; M. '32), Civ. Engr. (Allen & Rowe), 309 G. St. (Res., 4267 Witherby St.), San Diego, Calif.

SHULTZ, ROSS ELY (Jun. '29; Assoc. M. '31), Asst. Div. Engr., State Dept. of Highways, 334 West Bryan, St., Bryan, Ohio.

STANTON, WILLIAM LEWIS (Jun. '17, Assoc. M. '22; M. '32), Eden West, Lancaster, Pa.

STEINBERG, SAMUEL SIDNEY (Assoc. M. '27; M. '31), Head of Dept. and Prof. of Civ. Eng., Univ. of Maryland, College Park, Md.

TARLETON, COLBY DUTOT (Jun. '25; Assoc. M. '31), Engr. in Chg. of Sewer Projects, Board of Water Supply, Box 2542, Honolulu, Hawaii.

UHRIG, LEO VERNON (Jun. '27; Assoc. M. '32), Instr., Civ. Eng., The Rice Inst., Houston, Tex.

VIOLA, FELIX (Jun. '30; Assoc. M. '32), Designer, N.Y.C.R.R. (Res., 24 Oliver St.), New York, N.Y.

WOODYARD, JACOB FRANK, JR. (Assoc. M. '15; M. '32), (J. F. Woodyard, Jr. & Son), Monterey, N.L., Mexico.

RESIGNATIONS

ADAMS, FRANK, M., resigned Jan. 11, '32.

ANDERSON, LOUIS, M., resigned Jan. 11, '32.

ARMSTRONG, GEORGE SIMPSON, Assoc. M., resigned Feb. 3, '32.

BARKLEY, FRANCIS WARREN, Jun., resigned Jan. 11, '32.

BENGEL, GEORGE ADAM, Assoc. M., resigned Feb. 4, '32.

BUTTERFIELD, DYER, Assoc. M., resigned Feb. 5, '32.

CARPENTER, FORD ASHMAN, Affiliate, resigned Feb. 2, '32.

CLINTON, DELMAR SMITH, M., resigned Jan. 18, '32.

DIEBOLD, FERDINAND HEIM, Jun., resigned Feb. 4, '32.

ESTES, LEWIS ALDEN, M., resigned Jan. 11, '32.

EVELETH, BARTON HARVEY, Assoc. M., resigned Jan. 25, '32.

FONSECA, DAVID, Assoc. M., resigned Jan. 11, '32.

GRAF, JOHN ALFRED, Assoc. M., resigned Jan. 26, '32.

HARPS, HARRY MACY, Assoc. M., resigned Jan. 15, '32.

HOLDEN, WILLIAM, Assoc. M., resigned Feb. 3, '32.

JAMESON, JOHN ALEXANDER, JR., Jun., resigned Jan. 11, '32.

JESSEN, NILS HERMAN BAASHUUS, M., resigned Jan. 25, '32.

JOHNSON, LEWIS HAMILTON, Assoc. M., resigned Jan. 15, '32.

KEENAN, JOHN THOMAS, M., resigned Jan. 11, '32.

KEMMLER, EDWARD ALBERT, M., resigned Jan. 14, '32.

LEECH, EDWARD, Assoc. M., resigned Jan. 25, '32.

LEWIS, EDWARD ROWLAND, M., resigned Jan. 8, '32.

MASON, FRANCIS, M., resigned Jan. 20, '32.

MASSA, WILLIAM JACOB, Assoc. M., resigned Jan. 15, '32.

MONROE, RICHARD, M., resigned Jan. 11, '32.

MORRISON, CHRISTOPHER GEORGE, M., resigned Jan. 25, '32.

RAY, NORMAN GILMAN, Assoc. M., resigned Jan. 14, '32.

REID, WILLIAM S., Jun., resigned Jan. 16, '32.

ROSS, DANIEL, Assoc. M., resigned Jan. 21, '32.

SULLIVAN, MAURICE JOSEPH, M., resigned Jan. 18, '32.

TIETZEL, ALBERT MICHAEL, Assoc. M., resigned Jan. 11, '32.

WALTER, LLOYD DEWITT, Assoc. M., resigned Jan. 11, '32.

WIDMAYER, JOHN JOSEPH, Assoc. M., resigned Jan. 15, '32.

DEATHS

FUERTES, JAMES HILLHOUSE. Elected Jun. May 2, 1888, M., Feb. 6, 1895; died Jan. 30, 1932.

HACKNEY, JOHN WESLEY. Elected M., Oct. 5, 1909; died Jan. 30, 1932.

HARRINGTON, FERDINAND FINNEY. Elected Assoc. M., May 3, 1899, M., Feb. 2, 1909; died Feb. 8, 1932.

LYON, WARREN ADAMS. Elected Assoc. M., Oct. 14, 1919; died Jan. 14, 1932.

MITCHELL, WILLIAM SELBY. Elected M., June 1, 1909; died Jan. 27, 1932.

MOLERA, EUSEBIUS JOSEPH. Elected M., Oct. 5, 1904; died Jan. 14, 1932.

NOYES, STEPHEN HENLEY. Elected Jun., Oct. 1, 1907, Assoc. M., Feb. 6, 1912, M., Jan. 20, 1922; died Jan. 21, 1932.

ONDERDONK, ARTHUR. Elected Assoc. M., Jan. 6, 1915, M., Mar. 16, 1925; died Jan. 22, 1932.

PORTER, HENRY TEGMEYER. Elected M., Apr. 1, 1903; died Jan. 11, 1932.

RICHMOND, WALDEMAR SPAULDING. Elected Assoc. M., Oct. 3, 1911, M., Nov. 10, 1915; died Apr. 11, 1931.

ROWLAND, HERBERT RAYMOND. Elected Assoc. M., May 28, 1923; died Jan. 18, 1932.

SPELMAN, HOWARD RODGERS. Elected Jun., May 19, 1924; died Jan. 26, 1932.

TOLTZ, MAX ERNST ROBERT. Elected Assoc. M., Sept. 7, 1892, M., May 13, 1929; died Jan. 11, 1932.

TYE, WILLIAM FRANCIS. Elected M., Sept. 1, 1897; died Jan. 9, 1932.

YOST, FRANK DENNETT. Elected Assoc. M., Apr. 16, 1918; died Aug. 7, 1931.

TOTAL MEMBERSHIP AS OF FEBRUARY 9, 1932

Members	5,866
Assoc. Members	6,334
Corporate Members	12,200
Honorary Members	18
Juniors	2,860
Affiliates	123
Fellows	5
Total	15,206

Men and Positions Available

These items are from information furnished by the Engineering Societies Employment Service with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices and the fee is to be found on page 97 of the 1931 Year Book of the Society. Unless otherwise noted, replies should be addressed to the key number, Engineering Societies Employment Service, 31 West 39th Street, New York, N.Y.

Position Available

SALES EXECUTIVE. Successful engineering firm needs experienced man as vice-president, to secure contracts for the design of industrial plants and similar structures. Requires engineering education, knowledge of general manufacturing procedure, and particularly ability to sell the organization's services. Not a salaried position, but subject to generous commission for business secured. Applicant should have financial reserve to support himself for a year while demonstrating ability in expectation that he will soon become a partner. Apply by letter. Location, New York. W-3561.

Men Available

EXECUTIVE ENGINEER AND MANAGER; M. Am. Soc. C.E.; 37; married; graduate; 15 years hydro-electric projects and large work; experience on all types of foundations, dams, and other structures, domestic and foreign. Qualified to plan, organize, and manage plants for speed and cost reduction. Also estimates for price or other work, preliminary studies, estimates, and designs. C-9694.

CONSTRUCTION ENGINEER AND SUPERINTENDENT; Assoc. M. Am. Soc. C.E.; 10 years experience railroad location and construction; 18 years building construction, including office buildings, schools, banks, factories, sewers, pipe lines, and deep foundation work. Desires permanent connection as superintendent or engineer. Available at once. D-275.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 24; single; graduate of Johns Hopkins University; 3½ years experience in construction of highway bridges, railroads, and grade-crossing eliminations. Competent instrumentman; good draftsman. Wishes position immediately. Location immaterial. D-222.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; single; 5 years railroad experience in construction and drafting; fitted for office or field work. Thorough scholastic training in concrete and steel design. Location immaterial. D-279.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 43; married; Protestant; graduate Cornell, 1911. The quality and range of my experience in building construction and plant layout are sufficient to command the consideration of any firm needing the services of a thoroughly competent civil engineer. If you are in the market for a man of my caliber please communicate with A-3968.

PROFESSOR OF CIVIL ENGINEERING; M. Am. Soc. C.E.; member of S. P. E. E.; Methodist; Mason; B.S. in C.E.; 80 per cent of work for M.S. completed. Open for position teaching civil engineering or applied mechanics; 4 years railroad and city engineering practice; 12 years successful teaching experience. D-302.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 6 years survey experience; 4 years private practice on real estate surveys in field and office; 2 years on preliminary surveys of a large project including triangulation, topography, and soundings. Available immediately. C-4882.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; 1½ years experience as rodman and instrumentman in city highway department; 3 years experience in building construction as assistant engineer and engineer of office buildings, hotels, apartment houses, store buildings, hangar foundation, and complete set of buildings for water purification works. Available immediately. D-267.

CIVIL AND STRUCTURAL ENGINEER; Jun. Am. Soc. C.E.; married; graduate; registered engineer; 5½ years complete design, estimating, and drafting of railway and highway bridges and viaducts—also tunnel design; 2 years design and erection of concrete and timber buildings and structures. Available immediately. Location and salary open. D-324.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; married; graduate of Cornell University; 5 years experience in design, detail, and construction of sewers, water mains, and structural steel for railway electrification and subways. C-1632.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 24; single; 6 months fellowship in engineering in college; 1½ years experience in steel design, estimates, and as field assistant in subway construction. Desires connection with construction company, consulting engineer, or contractor. Salary secondary. Available immediately. Metropolitan location preferred. D-326.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 21; single; graduate of Rutgers University, 1931. Experience limited to summer positions in surveying work and four months private surveying. Interested in all branches of civil engineering. Salary and location immaterial; experience greatly wanted. D-318.

ASSISTANT PROFESSOR OF CIVIL ENGINEERING; Assoc. M. Am. Soc. C.E.; 36; married; B.S. in Eng.; M., C.E.; 8 years practical experience in construction and design; 7 years teaching experience in prominent Eastern university. Open for position teaching civil engineering courses—preferably structures, mechanics, and hydraulics. Qualified personally. Available short notice. D-316.

HIGHWAY ENGINEER; Jun. Am. Soc. C.E.; 24; single; graduate of University of Utah. Experienced in location and construction. Good draftsman and computer. Fair knowledge of Spanish. Salary secondary. References as to engineering ability and character. Available immediately. Location immaterial. C-8969-313-A-11 Chicago.

SANITARY AND SALES ENGINEER; Assoc. M. Am. Soc. C.E.; licensed New Jersey sanitary engineer; college graduate with 10 years experience in design and construction of sanitary works with consulting engineer and contractor, and in manufacturing, promoting, and selling of concrete pipe. Available on short notice. C-874.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 24; single; experienced in traffic surveys, triangulation, and road construction. Last position inspector and materials testing engineer for asphalt and concrete pavements. Salary secondary to opportunity offered. D-356.

STRUCTURAL AND SALES ENGINEER; Assoc. M. Am. Soc. C.E.; 28; married; graduate. Over 12 years experience in sales and sales management. Executive ability. Experience in designing, detailing, and estimating of bridges and buildings, specializing in steel. Desires position with building material manufacturer or general contractor. Available immediately. Capable and forceful. D-16.

HYDRAULIC AND CONSTRUCTION ENGINEER; Assoc. M. Am. Soc. C.E.; 33; married; 11 years experience in field investigations, designs, estimates, and construction of hydraulic works. Recently resident engineer on hydro-electric development, costing $2,500,000. Sound knowledge major earth dam construction. Available as field engineer, designer, estimator, or assistant superintendent on construction. C-360.

CIVIL ENGINEER; M. Am. Soc. C.E.; 36; married; honor graduate; 14 years thorough structural experience on steel, concrete, and timber design work; some valuation work; 8 years extension teaching in steel, concrete, theory of continuity, resistance of materials, building construction, drafting, and plan reading. Desires teaching position. Location immaterial. Salary open. Available immediately. B-9683.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; graduate of Purdue University, 1912; 6½ years teaching; 10 years road and bridge plans, surveys, specifications, estimates, contracts, and construction; 1 year airport design and construction; 2 years on steam power plant construction and safety work. Safety engineer. Middle West location preferred. D-373.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; B.S. in C.E., 1927; 4 years experience in railroad structures, hydro-electric developments, and industrial buildings. Available immediately. Location immaterial. D-372.

STRUCTURAL AND SALES ENGINEER; M. Am. Soc. C.E.; 44; married. Over 15 years experience directing estimating, designing, pricing, and sales of structural steel fabricating business in western Pennsylvania and Ohio districts. Desires connection with progressive concern. Available immediately. C-5095.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 8 years varied structural experience, steel and concrete design and construction, estimates, inspection, and surveys; familiar with track and steel layouts. Desires connection with construction company, consultant, contractor, or architect—preferably field engineering-construction or related work; also sales-engineering or instructorship. C-2605.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; married; graduate C.E.; 30 years experience in all classes of concrete, structural, and building work; details, design, field construction, purchasing, superintending, and research. Latest experience in full charge of power plant, development, design, and construction. Desires responsible executive position where previous experience will be of value. B-5239.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; graduate of Massachusetts Institute of Technology; 15 years experience on sewerage and water-works systems including construction of driven wells, filtration plants, pumping stations, pipe lines, and reservoirs. Preliminary investigations and reports. Special studies in economics and statistics. C-5106.

ASSOCIATE PROFESSOR STRUCTURAL ENGINEERING; Assoc. M. Am. Soc. C.E.; married; degrees B.S., M.S., C.E., University of Illinois; 3 years experience teaching major courses, structural theory, and design in ranking university; 5 years practice on reinforced concrete and steel structures, chiefly with Waddell and Hardesty, consultants; cantilever, arch, suspension, movable, and continuous-girder spans; technical writer; world-traveler. Desires position leading university. D-330.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 31; married; Tau Beta Pi; 9 years experience on design, development, construction, and maintenance of huge new chemical and power plants. Responsible for, and has made, investigations, surveys, estimates, designs, details, specifications, and requisitions for buildings, machinery, foundations, cranes, conveyors, and water supply. Desires permanent connection anywhere in United States. D-412.

GRADUATE CIVIL AND CONSTRUCTION ENGINEER; Jun. Am. Soc. C.E.; 26; married; 4 years field construction experience on concrete, heavy machinery, and buildings, including 2½ years responsible charge of industrial building construction. Location immaterial. Available immediately. C-5144.

STRUCTURAL ENGINEER; Jun. Am. Soc. C.E.; 26; single; master's degree in civil engineering, University of Illinois; 2¼ years with structural steel company, detailing and checking steel, reinforcing bars, and ornamental iron; 1½ years with consulting bridge engineer drafting and designing. Desires position as structural designer. D-376.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; single; college graduate, 1927; 4 years experience in structural design and drafting, alignment, and column location work in connection with subway structures. Desires position of a similar nature. Available immediately. C-3180.

ENGINEER; Jun. Am. Soc. C.E.; 25; married; civil engineering degree; 2½ years experience in construction including estimating, surveying, and supervision. Also minor periods at general office and statistical work. Due to pressing circumstances willing to take any kind of job in any location. D-379.

STRUCTURAL ENGINEER; M. Am. Soc. C.E.; American; technical graduate; 32 years experience designing, estimating, inspection, contracting for structural steelwork; reinforced concrete; masonry; wooden construction. Formerly assistant bridge engineer railroad; assistant chief engineer fabricating shop; foreign representative; in responsible charge of work. Licensed professional engineer, New York. D-344.

CIVIL ENGINEER AND EXECUTIVE; M. Am. Soc. C.E.; graduate; licensed; hydro-electric developments; housing groups for private interests and state institutions, including sewer and water systems and all other utilities; chemical and industrial plants. Experienced in organization and supervision of office forces, preliminary investigations, designs, working drawings, estimates, and construction. B-2835.

JUNIOR CIVIL ENGINEER; Jun. Am. Soc. C.E.; 22; graduate of Syracuse University, 1931; 9 months experience as assistant construction engineer, field and office work, with general building contractor. Desires opportunity with consulting engineers specializing in construction work, or connection with general building contractor. D-391.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; graduate of Massachusetts Institute of Technology; 4½ years experience in steel and concrete on fixed and movable bridges; also 1 year's experience in aerial photographic mapping. Desires employment where experience and education fit. Eastern states preferred but not essential. Nationality Chinese. Willing to work hard for any reasonable compensation. C-5378.

EXECUTIVE ENGINEER; M. Am. Soc. C.E.; Michigan registered civil engineer, registered architect; 25 years experience in architecture, engineering, and contracting as draftsman, specification writer, superintendent, estimator, engineer in charge, and practicing architect; 2 years as district sales representative. Graduate National Salesmen's Training Association. Desires position as sales engineer or in sales engineering promotion. Available immediately. C-6019.

STRUCTURAL AND CONSTRUCTION ENGINEER; Jun. Am. Soc. C.E.; 30; married; M.S. in Civil Engineering, Massachusetts Institute of Technology; 7 years experience on the design and construction of concrete structures of all classes, including hydraulic, and on control of concrete mixtures. C-6499.

CONSTRUCTION ENGINEER; Jun. Am. Soc. C.E.; 29; married; two children; C.E., Cornell University; 6 years excellent experience on foundations, bridges, concrete work, and paving. Desires position with opportunity for permanent connection. Salary and location secondary. Best of references can be furnished. D-397.

GRADUATE CIVIL ENGINEER; M. Am. Soc. C.E.; married. Experience includes 10 years subway, wharf, pier, and other heavy construction work and 10 years hydro-electric investigation, design, and construction, covering varied field. Available now. Location in New York district preferred, although not essential. B-5705.

ENGINEER EXECUTIVE; Assoc. M. Am. Soc. C.E.; 40; structural technical graduate; 17 years active design and supervision experience on heavy construction, viaducts, tunnels, railway terminals, plants, steam, hydro-electric projects, property development, surveys, and reports; organizer, with technical and business qualifications to handle complex coordination problems. Invites contact confidentially from engineers or managers. C-1445.

SANITARY AND MUNICIPAL ENGINEER; M. Am. Soc. C.E.; 37; married; graduate civil engineer; licensed New York; 12 years experience in responsible charge of water supply, filtration plants, sewerage and sewage disposal plants, power plants, municipal engineering, and valuation. Investigations, reports, design, and construction. Location immaterial. Available immediately. B-9270.

ENGINEER; Assoc. M. Am. Soc. C.E.; 33; graduate; 10 years experience, including petroleum production, transportation, and refining; highway, bridge, and municipal work. Competent designer. Has successfully directed large engineering organizations. Can furnish references as proof of ability. Moderate salary. D-408.

GRADUATE ENGINEER; Jun. Am. Soc. C.E.; 30; actively engaged for last 5 years in equipment and plan engineering, requiring constant contact with contractors and architects and a sound general knowledge of building construction. This experience will be of great value to an organization contemplating relocation, consolidation, or expansion. C-3270.

RECENT BOOKS

New books of interest to Civil Engineers, recently donated by the publishers to the Engineering Societies Library, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on pages 87 to 89 of the Year Book for 1931. The statements made regarding the books are taken from the books themselves and this Society is not responsible for them.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS GUIDE 1932, Vol. 10. New York, American Society of Heating and Ventilating Engineers, 1932. 876 pp., illus., diagrs., charts, tables, 9 × 6 in., half leather, $5.

An instrument of service prepared for the profession and containing reference data on the design and specification of heating and ventilating systems. This volume is based on the transactions, the investigations of the research laboratory and cooperating institutions, and the practice of the members and friends of the society. There is included a manufacturers' catalogue-data section, containing essential and reliable information on the subject of modern equipment, the roll of membership of the society, and complete indexes to the technical and catalogue data. Five new chapters have been added to the volume, and all other data have been rewritten.

AMERICAN SOCIETY OF MUNICIPAL ENGINEERS—PROCEEDING THIRTY-SIXTH CONVENTION. 1930–1931, Vol. 36. $7.50.

City Planning Committee Report, J. L. Crane, Jr.; Facilitating Traffic Flow at Street or Highway Intersections, E. P. Goodrich; Economic Value of Laying Out Roadway for Steady Flow Traffic, F. Malcher; Parkways and Super-Highways—Their Comparative Advantages in Interurban Planning, J. Downer; Utilization of Widened Streets, J. P. Hallihan; Does Zoning Retard Building Operations? F. J. Mulvinill.

EARTHQUAKE DAMAGE AND EARTHQUAKE INSURANCE. By J. R. Freeman. New York and London, McGraw-Hill Book Co., 1932. 904 pp., illus., charts, maps, tables, 9 × 6 in., cloth, $7.

Dr. Freeman presents a great amount of information upon the occurrence of earthquakes and the damage caused by them, which he has collected from published reports and by personal observation. This information is arranged to meet the needs of the structural engineer interested in the design of earthquake-resistant structures. In addition, he discusses the problem of earthquake insurance and attempts to find a rational basis for rules and rates of premiums. The book, which is a comprehensive review of present knowledge of earthquakes and methods of safeguarding life and property, will be of value to all structural engineers.

ERHÄRTUNG UND KORROSION DER ZEMENTE. By K. E. Dorsch. Berlin, J. Springer, 1932. 120 pp., illus., diagrs., charts, tables, 10 × 6 in., paper. 13.50 r.m.

Dr. Dorsch has been active in investigation of the chemistry of cement, especially the phenomena of setting and hardening, and the behavior of cement when exposed to corrosive agents. The results of his experiments, the conclusions deduced from them, and the problems still awaiting investigation are considered in his book.

FARADAY AND HIS METALLURGICAL RESEARCHES. By Sir. R. A. Hadfield. London, Chapman & Hall, Ltd., 1931. 329 pp., illus., diagrs., charts, tables, 10 × 6 in., cloth. 21 s.

It will surprise many who think of Faraday chiefly as the discoverer of electromagnetic induction, to learn that he was also the first to conduct systematic researches upon alloy steels and that his work, far in advance of the demand of his day, was not only valuable but is still of great interest. A happy chance has enabled Sir Robert Hadfield to investigate thoroughly by modern methods, a large number of alloys which Faraday made and packed away over a century ago. These entitle Faraday to credit as the pioneer student of alloy steels and show the remarkable work that he did from 1819 to 1824, when his efforts in this field were discontinued.

KIDDER-PARKER ARCHITECTS' AND BUILDERS' HANDBOOK, 18th edition. By F. E. Kidder and H. Parker. New York, John Wiley & Sons, 1931. 2315 pp., diagrs., charts, tables, 7 × 5 in., leather, $8.

This new edition, edited by Prof. Harry Parker of the University of Pennsylvania, is the first complete revision of this well-known reference book since 1915. Obsolete matter has been omitted, and many chapters have been rewritten. New chapters on elevator service, copper roofs, cost estimating, wind stresses, and other topics have been added.

PLANNING PROBLEMS OF TOWN, CITY, AND REGION. Papers and discussions at the 23rd National Conference on City Planning held at Rochester, N. Y., June 22 to 24, 1931, publ. for the conference by Wm. F. Fell Co., Phila., 1931. 228 pp., illus., tables, diagrs., 9 × 6 in., cloth. $3.

Among the topics discussed in this volume are: is city planning effectively controlling city growth; mass transportation on city streets; master plans and official maps; zoning administration; the edges of zones; county planning; the relation of special assessments to city planning; planning programs for small cities; the prevention of blight in residential areas adjacent to expressways. These and other subjects are discussed by experts.

SYMPOSIUM ON WELDING. American Society for Testing Materials. Philadelphia, 1931. 151 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth. $1.75.

Contains the eleven papers presented at a meeting of the society in Pittsburgh, March 1931, with the discussions that ensued. These include a general survey of processes, an account of processes for welding aluminum, and papers on materials for fusion welding, modern applications of arc welding, and recent developments in gas welding. Several other papers discuss such matters of inspection and testing as the use of the stethoscope gamma-ray testing, magnetic testing, and fatigue and impact tests.

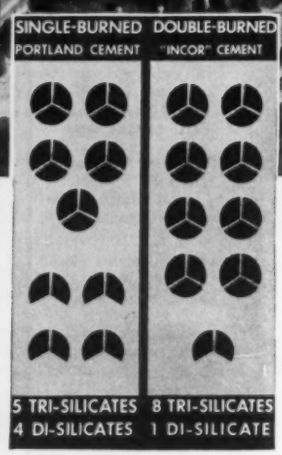
THOMAS A. EDISON, BENEFACTOR OF MANKIND. By F. T. Miller. Chicago, Philadelphia, Toronto, John C. Winston Co., 1931. 320 pp., illus., diagrs., 9 × 6 in., cloth. $1.50.

A well illustrated popular life of Edison, the first since his death. The author has had the cooperation of the family and of associates of Edison and has produced an excellent account.

TALSPERREN (SAMMLUNG GÖSCHEN 1044). By N. Kelen. Berlin and Leipzig, W. de Gruyter & Co., 1931. 144 pp., illus., diagrs., charts, tables, 6 × 4 in., cloth, 1.80 r.m.

A simple condensed exposition of the principles of dam design and construction.

The day Lindbergh



WHERE ROAD HISTORY WAS MADE. U. S. Route No. 20, at the Pere Marquette Railroad Underpass near Springville, Indiana. Here 'Incor' concrete was used on a State highway for the first time in May, 1927. Twenty-four hours after pouring, the road was opened . . . *Highway transportation had taken a quiet but momentous step forward on the same day that Lindbergh made history in the air.*

THE CHEMISTRY OF THE SUCCESS. (*Left*) The diagram illustrates the difference in chemical constitution between ordinary Portland Cement and 'Incor'. The complete circles symbolize molecules of *tri*-calcium silicate, which are active. The incomplete circles symbolize molecules of *di*-calcium silicate, which are sluggish. This difference in refinement, which insures high *early*-and-*ultimate* strength is achieved by 'double-burning', an exclusive 'Incor' feature; and it explains 'Incor's unrivalled records at Springville and elsewhere.

flew to Paris this road was laid

Core tests 4 years later prove that this job also made history

MAY 20, 1927. A memorable day in the annals of aviation. Charles Lindbergh, after a sensational flight across the continent, rose from Roosevelt Field, and the next day roared to a landing in Paris. *Who can forget that day?*

When Lindbergh flew across Indiana, near Springville, a simple road-making job was in progress. Lindbergh certainly knew nothing about it. Few persons did.

But the day Lindbergh landed in Paris—24 hours after the last concrete was poured—this road was opened. There was no public excitement about that event. It seemed an ordinary incident. True, the road-builders were intensely excited. Motorists were amazed to see a new road opened overnight. And engineers rubbed their eyes, as it were, to see concrete attain service strength so soon.

But the general public drove on, unheeding.

And yet this little road-job marked a new day in highway transportation just as surely as Lindbergh's flawless flight marked a new day in aerial transportation.

The people who laid that road thought so then. Now they know it.

"Death-Knell of Detours"

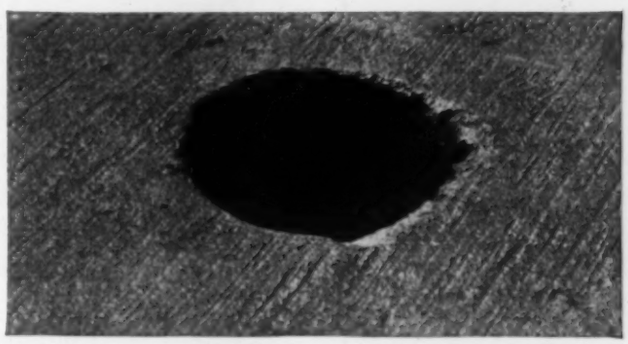
This job struck what may be called the death-knell of detours, the end of "dead time", waiting for ordinary concrete to gain service strength. It marked the first State Highway use of 'Incor' 24-hour Cement.

'Incor' had been tested in the laboratory for more than a year before, as well as in many jobs. But service tests under heavy highway traffic were needed.

So when word came from the Indiana State Highway Department that they would use 'Incor' in closing a gap where U. S. 20 went under the Pere Marquette Railroad, the Company lost no time in sending the Chief Chemist and other representatives to the spot, with moulds and apparatus for making test cylinders. The State Highway Department was similarly represented.

As the concrete was poured, the cylinders were filled. The testing laboratory was at Indianapolis, 165 miles away. As soon as the specimens could be handled without damage, a driver took off for Indianapolis and drove there at night. *That night Lindbergh was flying to Paris.*

The driver reached the laboratory on time, and the 24-hour cylinders were placed in the compression machine. Their average strength was *2198 pounds per square inch.*



'INCOR' PAVEMENT AND CORE HOLE. An 'Incor' core has just been cut after four years of traffic. The three cores from U. S. 20 developed an average strength of *9604 pounds per square inch.*

At 48 hours more cylinders were tested, and they showed an average strength of 3463 pounds per square inch.

This was no ordinary concrete. Yet only the normal amount of cement had been used. Accelerators and admixtures were absent. Here at last was a pure Portland cement that obtained high early strength *unaided.*

Similar cylinders tested at 7 days and 28 days revealed average strengths of 3370 and 4939 pounds per square inch, respectively. *There* was proof of high early strength no one could question. What about ultimate strength?

For four years and 3 months this road carried traffic. The time came to make the most important test of all.

Concrete cores were drilled from the body of the pavement and one by one were placed in the compression machine in the presence of public officials.

Each of these cores bore the amazing pressure of over 9000 pounds per square inch, *an average of 9604.*

Cores taken from an adjoining section of the pavement made with ordinary Portland Cement, developed an average strength of 7854 pounds per square inch—a remarkable strength—and yet 1750 pounds per square inch less than the 'Incor'* concrete.

Traffic strength at 24 hours—9000 pounds at 4 years. This combination of high early and high-ultimate strength made road history on Route 20 *and is now being repeated in hundreds of jobs throughout the country.*

* Reg. U. S. Pat. Off.

'INCOR' 24-*Hour Cement*

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BRIDGES

CABLES. Strand-Cable Suspension Bridges, C. M. Jones and D. B. Steinman. *Eng. News-Rec.*, vol. 108, no. 2, Jan. 14, 1932, pp. 70–71. Discussion of nomenclature for cables of suspension bridges.

CANADA. New Bridge on No. 2 Highway at Paris, A. Sedgwick. *Can. Engr.*, vol. 62, no. 2, Jan. 12, 1932, pp. 7–10. Construction of steel-arch highway bridge 1,169 ft. long and 36 ft. wide, comprising seven spans varying from 96 to 204 ft. in length, the longest one being unsymmetrical.

CAUSEWAYS. East African Causeway, J. R. Paris. *Surveyor*, vol. 80, no. 2083, Dec. 25, 1931, pp. 625–626. Construction of Makupa Causeway connecting the Port of Kilindini, on the island of Mombasa, with the mainland; waterway bridged is 1,296 ft. wide with ordinary spring tides of 15 ft., bridge portion being 300 ft. long and the balance an earth bank causeway; the bridge is in five spans of 60 ft. each, supported on six masonry piers built on 12-ft. concrete cylinder piles, sunk three abreast.

FLOORS. Effect of Materials and Methods of Placing on Strength and Other Properties of Concrete and Bridge Floor Slabs, L. W. Teller and G. W. Davis. *Pub. Roads—Journal*, vol. 12, no. 10, Dec. 1931, pp. 237–266. Co-operative investigation by the Port of New York Authority and the U. S. Bureau of Public Roads; effects of age, method of placing, and type of aggregate on flexural strength of concrete; bond strength of steel bars; absorption tests; resistance to wear and repeated freezing.

HIGHWAY, SUBMERSIBLE. Submersible Bridges, R. P. Mears. *Engineer*, vol. 152, no. 3960, Dec. 4, 1931, p. 602. Problems of design; submersible bridge is purposely arranged to be below the level of high floods, and so constructed that high floods may pass over it without damage to the structure; the ideal solution is a heavy structure built in combination of masonry and reinforced concrete; arches of barrel type are best. Before Inst. Structural Engrs.

MOVABLE. Jack-Knife Draws Originated Nearly 100 Years Ago, J. P. Snow. *Eng. News-Rec.*, vol. 108, no. 3, Jan. 21, 1932, pp. 93–94. New England type of swing bridge, now abandoned, was developed by J. Ross about 1845 for Eastern Railroad; some plans of its later adaptation to modern loads.

PAINTING. Protecting Bridges with Paint, W. B. Roberts. *Highway Engr. and Contractor*, vol. 39, no. 22, Dec. 1, 1931, pp. 27–29 and 42, 11 figs. Specifications for bridge paintings, including aluminum paint.

RAILROAD CONSTRUCTION. What Bridge Work in Winter? F. H. Cramer. *Ry. Eng. and Maintenance*, vol. 27, no. 11, Nov. 1931, pp. 974–975, 1 fig. Problems encountered and methods employed in winter bridge construction.

STEEL, PAINTING. Three Years Required for Painting Quebec Bridge. *Contract Rec.*, vol. 45, no. 51, Dec. 23, 1931, p. 1509. 7,500 gal. of paint needed for a single coat; 40 men in crew; spray method saves cost.

STEEL ARCH, BOSTON. Unique Ribbed-Arch Bridge Used for Parkway Overpass. *Eng. News-Rec.*, vol. 107, no. 26, Dec. 24, 1931, pp. 993–995, 5 figs. Design and construction of structure resembling in appearance rigid-frame bridges developed in Westchester County, N.Y., but designed as three-hinged arch; steel ribs are concrete-incased and stone-faced; span is 71.5 ft. long.

STEEL TRUSS, RECONSTRUCTION. Reconstructing Dynamited Bridge, P. Emery. *Eng. News-Rec.*, vol. 107, no. 26, Dec. 24, 1931, pp. 1005–1006, 4 figs. Wrecked structure at Garland City, Ark., required new 300-ft. center span, which was erected without falsework, and new end post and floor beams in adjacent spans; erection diagram.

SUSPENSION, MAYSVILLE, KY. Speedy Erection of Parallel-Strand Cable Bridge. *Eng. News-Rec.*, vol. 108, no. 2, Jan. 14, 1932, pp. 46–50. Construction of suspension bridge having a span of 1,060 ft. over the Ohio River, at Maysville, Ky.; towers 165 ft. high were erected in 8 days and cables in 9 days, using foot-bridges; aluminum fillers transform hexagonal cable to 13-in. circle for wrapping.

SYDNEY, AUSTRALIA. Sydney Harbor Bridge. *Engineering*, vol. 133, no. 3442, Jan. 1, 1932, pp. 16–17. Non-technical history of bridge to be opened for traffic on March 19; based largely on broadcast addresses given by principal designing engineer, Bradfield, in Australia; reference to Bradfield's conviction that a bridge is a better solution of the problem of cross-harbor transportation than a subway.

VIADUCTS, CHICAGO. Chicago's New Diagonal Thoroughfare. *Eng. News-Rec.*, vol. 107, no. 25, Dec. 17, 1931, pp. 952–956, 8 figs. Completion of three-quarters of a mile of viaduct, costing $5,500,000 which will close the last gap in the 12-mile avenue leading to lakefront; viaduct includes steel and reinforced-concrete construction and has two bascule bridges; future grade separation; details of reinforced-concrete and of steel viaducts, retaining walls, and fills.

BUILDINGS

REMODELING. Removing Lower Part of Steel Column in Fourteen-Story Building, F. P. McKibben. *Contractors and Engrs. Monthly*, vol. 23, no. 5, Nov. 1931, pp. 49–50. In making alterations at the Du Pont Company's office building, Wilmington, Del., removal of the lower portion of the column required use of new girder, to which column's load of 460,000 lb. was transferred by hydraulic jacks; column was welded to girder and lower part removed with oxyacetylene torch.

WELDED. Arc Welding Solves Some Problems at Du Pont Company's Fourteen-Story Office Building in Wilmington, Del., F. P. McKibben. *Gen. Elec. Rev.*, vol. 34, no. 12, Dec. 1931, pp. 725–728, 6 figs. Three extensions and alterations, involving structural steel details, have been made; data regarding field welding of first project; study illustrating computations for deflection of girder at column No. 577; strength calculations for live and dead loads are given.

CITY AND REGIONAL PLANNING

CLEVELAND. Cleveland's Planning Progress, C. E. Conley and W. J. Murphy. *City Planning*, vol. 8, no. 1, Jan. 1932, pp. 1–10. Early planning efforts; zoning in Cleveland; land subdivision control; regional planning.

EXPRESSWAYS. Expressway in the Region, R. Whitten. *City Planning*, vol. 8, no. 1, Jan. 1932, pp. 22–27. The functions and general principles of design of expressways in metropolitan communities; typical cross sections for expressways through metropolitan residence area.

HIGHWAY SYSTEMS. Influence of Transport on Regional Planning, J. Paterson. *Inst. Transport—Journal*, vol. 13, no. 2, Dec. 1931, pp. 61–69 and (discussion) 69–75. Historical review of developments in modern transportation and effect of developments upon city growth; need for changes in Great Britain.

CIVIL ENGINEERING

EDUCATION. Philosophy of Civil Engineering Training, H. R. Lintern. *Surveyor*, vol. 80, no. 2080, Dec. 4, 1931, pp. 557–558. Further systems of engineering training; general thoughts on profession. (Concluded.)

UNEMPLOYMENT. Professional Unemployment—Its Effect on Civil Engineers, H. M. Friend. *Eng. News-Rec.*, vol. 108, no. 2, Jan. 14, 1932, pp. 68–70. Statistical review of unemployment among civil engineers; occupational analysis of engineers; registrations and placement record of Engineering Societies' Employment Service.

CONCRETE

AGGREGATES, MINE RESIDUES. Crushed Stone and Concrete Sand from Waste and Mill Tailing, A. H. Hubbell. *Eng. and Min. Journal*, vol. 132, no. 12, Dec. 28, 1931, pp. 526–528, 5 figs. Practice at Scrub Oaks iron mine at Dover, N. J.

CONSTRUCTION. Monolithic Concrete Construction, J. F. Hough. *Constructor*, vol. 13, no. 12, Dec. 1931, pp. 19–20, 3 figs. Use of plaster molds for forming ornament and fiberboard forms for smooth, line-free, plane surfaces; molds are left in place.

RAILROAD CONSTRUCTION, CONCRETE. Winter no Bar to Concrete Work, H. L. Flodin. *Ry. Eng. and Maintenance*, vol. 27, no. 12, Dec. 1931, pp. 1050–1051, 3 figs. Thoroughly tried methods of heating aggregates and protecting material during hardening leave no grounds for apprehension concerning desired strength and durability; protection of concrete; use of chemicals.

READY-MIXED PLANTS. Nine Years' Experience Goes Into This Ready-Mix Plant, C. Laine. *Concrete Products*, vol. 40, no. 12, Dec. 1931, pp. 22–24, 6 figs. Description of the new plant of the Fort Worth Sand and Gravel Company, Fort Worth, Tex.; auxiliary equipment insures production; material handling; use of compressed air to prevent bridging; truck delivery.

ROCK PRODUCTS INDUSTRY, MISSOURI. Aggregate Industry in Kansas City (Missouri) Territory, W. B. Lenhart. *Rock Products*, vol. 34, no. 20, Sept. 26, 1931, pp. 17–29, 41 figs. Analysis of broad economic factors which are changing the character of the aggregate industry everywhere and how specific economic factors have already had enormous influence in Kansas City; improvements in preparing Missouri River sand; evolution of crushed-stone industry.

STONE SAND. Making of Stone Sand, E. Shaw. *Rock Products*, vol. 34, no. 25, Dec. 5, 1931, pp. 32–34, 2 figs. Stone sand or crusher sand is made in two ways: by washing screenings from coarse crushing and grading them so that they are suitable for concrete fine aggregate, and by crushing larger pieces to sand size; example of natural grading and how to improve it; use of rolls for fine crushing.

VIADUCTS. Tunkhannock Viaduct—Report on 17 Years' Service, M. Hirschthal. *Eng. News-Rec.*, vol. 108, no. 2, Jan. 14, 1932, pp. 57–59. Thorough examination of Tunkhannock Viaduct of the Lackawanna Railroad, in Nicholson, Pa., discloses perfect concrete, marred only by contraction cracks in the parapet and discoloration from floor drainage blown against the piers; reasons for good condition; deck joints and waterproofing.

CONSTRUCTION INDUSTRY

AUSTRALIA. Tendencies in Building Construction—II, R. P. Morris. *Commonwealth Engr.*, vol. 19, no. 5, Dec. 1, 1931, pp. 172–178. Review of building construction in Australia and abroad with special reference to regulations governing structural design, wind loads, and properties of steels used in building construction; comparative designs of steel-framed city buildings under building regulations of various cities and authorities; economic importance of codes.

COSTS. Unit Bid Summary. *West Construction News*, vol. 7, no. 1, Jan. 10, 1932, p. 32. Unit prices bid on construction of street and road work and water supply systems; irrigation and reclamation works in California, Oregon, Washington, and other Western states.

UNITED STATES. Effect of Reduced Population Growth on Construction Demand, T. S. Holden. *Arch. Rec.*, vol. 71, no. 1, Jan. 1932, pp. 3–8. Relationship between construction demand and population growth; day of individualistic planning is on the wane; building demand of the future will be created on a basis of community planning and community co-operation.

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DAMS

CONCRETE ARCH. New Type of Dam, A. C. Janni. *Eng. News-Rec.*, vol. 108, no. 2, Jan. 14, 1932, p. 71. Articulated arch dam proposed as a solution of the difficulties inherent in gravity and present arch dam types.

CONCRETE GRAVITY. Treatment of Foundations of Woronora Dam for Sydney Water Supply, A. Chalmers. *Commonwealth Engr.*, vol. 19, no. 3, Oct. 1, 1931, pp. 89–98, 14 figs. Lines and initial stages of construction of curved gravity dam, 222 ft. high, built of sandstone cyclopean concrete; geological report on site; preliminary stripping; test of sand seams; cut-off trench; driving test pipes; grouting of tunnels.

CONSTRUCTION. Precise Concrete Control at Koon Dam. *Eng. News-Rec.*, vol. 107, no. 27, Dec. 31, 1931, pp. 1024–1027, 7 figs. Construction of concrete-gravity dam in Pennsylvania; 92 ft. high; semi-automatic batching and mixing plant installed to meet rigid concrete specifications; dry mix requires tamping with vibrators.

RESERVOIRS. Fort Canning Covered Service Reservoir Singapore, E. F. Redi. *Water and Water Eng. (Special Inst. Number)*, vol. 33, no. 398, Winter 1931, pp. 655–666 and (discussion) 666–671. Design and construction of filtered water reservoir, located on top at hill, having length of 814 ft., width of from 241 ft. to 345 ft., average water depth of 25 ft., and a capacity of 30,000,000 gal.; details of floor, columns, and roof; roof drainage; walls, buttresses, valve houses, wells, and inspection houses; composition and testing of concrete.

FLOOD CONTROL

LEVEE CONSTRUCTION. Building Flood Control Levee with Power Drag Scraper, T. G. Smith. *Contractors and Engrs. Monthly*, vol. 23, no. 5, Nov. 1931, pp. 57–58, 3 figs. Construction of section of flood control levee along Los Angeles River, California; operation of 1-yd. Northwest dragline with 40-ft. boom and 1½-yd. Sauerman Cresent drag scraper; handling earth over maximum span of 175 ft. from borrow pit to levee.

FLOW OF FLUIDS

CURRENT METERS. Making Water Measurements with Current Meters, S. J. Bitterli. *Power*, vol. 75, no. 3, Jan. 19, 1932, pp. 102–104. Current meters are used extensively in Europe for measuring the flow of water to hydro-electric plants; much of this work has been done by S. Bitterli of Rheinfelden, Switzerland; résumé of some current-meter work that is being done in Europe.

METERS. Measurement of Flow, J. N. Williamson. *Colliery Eng.*, vol. 8, nos. 91, 92, 93, and 94, Sept. 1931, pp. 343–346, Oct., pp. 388–390, Nov., pp. 404–408 and 430, and Dec., pp. 447–450, 23 figs. Practical application, to coal mine work, of methods of measurement of flow of broken coal, of water, of steam, and of air.

WIND TUNNELS, ROUMANIA. Wind Tunnel of Bucharest Polytechnic Institute. *Nat. Advisory Committee Aeronautics—Tech. Memo.*, no. 651, Dec. 1931, 2 pp., 10 figs. on supp. plates. Design and construction of horizontal closed-circuit tunnel; diameter 10.5 ft. at entrance cone and 4.92 ft. at test chamber; speed of 136.8 ft. per sec. reached with only 32 hp.; efficiency factor 3.35.

FOUNDATIONS

FOUNDATIONS, CONSTRUCTION. Foundation Methods—VI, W. D. Chapman. *Commonwealth Engr.*, vol. 19, no. 5; Dec. 1, 1931, pp. 179–186. Caissons and cylinders; hours of cylinder employees; special methods; underwater work.

INLAND WATERWAYS

CANAL LOCKS, GATES. Piping Arrangements in "Gate Lifter," C. G. Moon. *Heat Piping and Air Conditioning*, vol. 3, no. 12, Dec. 1931, pp. 1025–1027. Features of gate lifter employed to make necessary repairs to steel gates for locks in Welland ship canal; piping arrangements; equalizing system of piping.

ROCK DRILLING. Drill Truck Bottoms Nineteen Hundred Holes a Day, F. J. Meystre, Jr. *Eng. News-Rec.*, vol. 107, no. 27, Dec. 31, 1931, pp. 1039–1041. Rock bottom of West Beenish Channel in St. Marys River being deepened 6 ft. by cut 9,400 ft. long and 3.0 ft. wide, using gang-drill trucks with ten drills.

IRRIGATION

DESIGN. Economic Bed Fall of Canals, N. S. Joshi. *Bombay Eng. Congress—Paper*, vol. 20, no. 135, Dec. 1931, pp. 37–46, 1 supp. plate. Theoretical discussion leading to the revision of formulas for selection of the most economic slope of bottom of irrigation canals.

INDIA. Design and Construction of Sarda Canal, B. Darley. *Engineering*, vol. 132, no. 3439, Dec. 11, 1931, p. 725. Canal will command country 200 miles long by 50 miles wide of which 1,350,000 acres will be irrigated annually; headworks consist of a dam with 34 bays of 50-ft. span, each closed by steel gates with quick-release gear to enable whole to be thrown open quickly in case of floods. Before Inst. Civil Engrs.

MATERIALS TESTING

CASTINGS, TESTING. Constructive Testing Is an Aid to Designers of Castings, F. C. Edwards. *Foundry*, vol. 59, no. 23, Dec. 1, 1931, pp. 52–55, 7 figs. Results obtained from tests which show that addition of weight to casting does not always increase strength but often tends to reduce that property. Before Inst. Brit. Foundrymen.

CEMENT, PROPERTIES. Anhydrite Cement—Its Tensile Strength, Solubility, and Plasticity, P. P. Budnikoff. *Pit and Quarry*, vol. 23, no. 2, Oct. 21, 1931, pp. 57–58 and 64. Mixture of sodium bisulfate and copper sulfate has been found to be the best catalyst for use in the manufacture of anhydrite cement; tabular data of tests to determine properties.

HARDNESS TESTING MACHINES. Vickers Pyramid Diamond Hardness Testing Machines, G. R. Barclay. *Metal Industry (Lond.)*, vol. 39, no. 16, Oct. 16, 1931, pp. 371–373, 7 figs. Limitations of Brinell test; construction and operation of Vickers machine; relation between Vickers and Brinell figures.

METALS, CREEP. Creep Properties of Metals, H. J. Tapsell. *Structural Engr.*, vol. 10, no. 1, Jan. 1932, pp. 15–25. Ultimate stress and comparative resistance to prolonged stress of nickel-chromium, steel, and brass; creep curves; limiting creep stresses and short-time tensile properties; comparison of low alloy steels with carbon steel; working stresses for medium carbon steel; high alloy steels; non-ferrous metals.

PLATES, STRESSES. Deflections and Stresses in Stayed Plates, J. L. Taylor. *Engineering*, vol. 132, no. 3438, Dec. 4, 1931, pp. 692–693. Theoretical mathematical analysis; comparison with experimental results.

TESTING MACHINES, CANADA. Canada's Largest Testing Machine. *Contract Rec.*, vol. 45, no. 51, Dec. 23, 1931, pp. 1501–1504, 7 figs. Details of equipment having capacity of 1,000,000 lb., recently built in England for Ontario Department of Mines.

PORTS AND MARITIME STRUCTURES

LEGHORN, ITALY. Development Works at Port of Leghorn, B. Cunningham. *Engineering*, vol. 133, no. 3443, Jan. 8, 1932, pp. 31–33. Scheme designed by E. Coen Cagli takes advantage of tract of low marshy ground to form site for a series of inner basins approached by channel from outer port through Vittorio Emanuele III Basin; construction of quay walls.

VALPARAISO, CHILE. Improvement of Port of Valparaiso, and Extension of Breakwater, W. F. Stanton. *Engineering*, vol. 132, no. 3440, Dec. 18, 1931, pp. 770–771. Completion of block setting of mooring jetty, and settlement which took place therein. Before Inst. Civil Engrs.

WATERWAY TRANSPORTATION. Proceedings, 20th Annual Convention of American Association of Port Authorities. *World Ports*, vol. 20, no. 2, Dec. 1931, pp. 83–149. Reports on XV International Navigation Congress; Conference on Merchant Marine; zinc coating of iron and steel; Government legislation; specialized types of carriers in Great Lakes Traffic, H. E. Cornell; Great Lakes as Arteries of Commerce, L. Brown; policy required to correctly operate publicly owned rail-water terminal facilities, J. R. Wait.

RAILROADS, STATIONS, AND TERMINALS

MONTREAL. Station Built at Park Avenue, Montreal, by Canadian Pacific Railway. *Can. Ry. and Mar. World*, no. 406, Dec. 1931, pp. 745–747. General layout and architectural features of Park Avenue Station, Montreal.

ROADS AND STREETS

BITUMINOUS. Manufacture of Asphalt Paving Materials, D. M. Wilson. *Quarry and Roadmaking*, vol. 36, no. 418, Dec. 1931, pp. 523–527, 6 figs. Manufacture of compressed asphalt paving; asphalt slab paving; mastic asphalt paving; steam-rolled asphalt; testing of asphalt paving materials. Before Soc. Chem. Industry.

BRICK. Ohio Brick Pavement Construction Pictured. *Roads and Streets*, vol. 75, no. 1, Jan. 1932, pp. 14–15. Rubber expansion joint filler tried out for first time on paving job.

CONCRETE. Concrete Road Construction Marked by Precision, E. M. Fleming. *Eng. News-Rec.*, vol. 108, no. 1, Jan. 7, 1932, pp. 14–17. Major processes and equipment exhibit greater precision and perfection of detail, with increased output and reduced cost of paved surface; materials and mixes; proportioning plants; mixer practice; joint construction; finishing and curing; crews, outputs, and costs.

CONSTRUCTION. Machinery Revolutionizes Highway Grading, H. J. Spelman. *Eng. News-Rec.*, vol. 108, no. 1, Jan. 7, 1932, pp. 10–13. Greater volumes, reduced time, better placing, and freedom of traffic movement have greatly magnified machine operations in road excavation and embankment; reasons for increased grading; equipment progress; compaction of fills; costs of grading.

COSTS. Unit Bid Summary. *West Construction News*, vol. 6, no. 24, Dec. 25, 1931, pp. 28, 30, and 32. Unit costs of street and road work, also bridge construction, in California, Arizona, and other Western states.

HIGHWAY ADMINISTRATION. Urgent Problems Confront Public Road Officials, T. H. MacDonald. *Eng. News-Rec.*, vol. 108, no. 1, Jan. 7, 1932, pp. 4–6. Problems of administration, financing, transportation, and engineering; state control of county roads; rational road classification; utilization of tax funds; restriction of interstate traffic; vehicular weight, size, and speed; highway safety; subgrade research.

INTERSECTIONS. No Traffic Jams at This Highway Junction. *Construction Methods*, vol. 14, no. 1, Jan. 1932, pp. 34–36. Construction of complicated highway intersection in swampy ground, requiring removal of 17 ft. of mud to reach solid bottom.

LOW COST. Low-Cost Paving with Gravel Asphalt Mixed at Pit, W. McK. White. *Eng. News-Rec.*, vol. 107, no. 26, Dec. 24, 1931, p. 1004, 1 fig. Practice of Macomb County, Michigan; portable asphalt plant at local pit produces gravel-asphalt surfacing at cost of $3 a ton, in place and ready for traffic.

MACADAM. Handling Hot Mix with Spreader Boxes. *Contractors and Engrs. Monthly*, vol. 24, no. 1, Jan. 1932, pp. 77–81. Materials, equipment, and methods used in construction of 5.85-mile mixed-macadam highway at Guelph, Ont.; crushed stone produced by reformatory labor; old penetration macadam scarified for base; handling of asphalt and fuel oil; completing shoulders.

MACHINERY. In One Operation Bituminous Paving Machine Mixes, Lays, Spreads, and Tamps. *Contract Rec.*, vol. 45, no. 50, Dec. 16, 1931, pp. 1478–1480, 6 figs. Description of Barber-Greene bituminous paver manufactured by Barber-Greene Co., Aurora, Ill.

MAINTENANCE AND REPAIR. Treatment of Ice-Covered Roads, A. C. White. *Can. Engr.*, vol. 61, no. 25, Dec. 22, 1931, p. 14. Winter maintenance of roads by use of calcium chloride.

MATERIALS, BITUMINOUS. Some Considerations Affecting Use of Coal Tar for Road Surfacing Operations, H. Pickard. *Quarry and Roadmaking*, vol. 36, no. 418, Dec. 1931, pp. 528–531. Purpose of surface tarring; methods adopted in practical construction; tests with asphaltic bitumen mixtures in varying proportions; failure of tar-mastic type of surface to adhere to road surface; increase in consistency of tar due to volatilization; spread of tar; rolling freshly-tarred roads.

PLANNING. Highway Location Controlled by Engineering Economics, R. G. Browning. *Eng. News-Rec.*, vol. 108, no. 1, Jan. 7, 1932, pp. 7–9. Review of general requirements of good location, with examples of existing locations that exhibit both good and bad practice; suggested minimum requirements for surveys for various classes of roads in different types of country.

ROAD SURFACE TREATMENT. Rock-Asphalt Seal Coat for Mixed-in-Place Surfaces, W. W. Webster. *Eng. News-Rec.*, vol. 107, no. 27, Dec. 31, 1931, p. 1036. Experience of Tennessee Department of Highways; 8-in. rock-asphalt surface spread perfectly by blade graders on bituminous macadam road.

SLIPPERINESS. Slipperiness in Road Surfaces, Its Causes and Cure, B. H. Knight. *Civ. Eng. (Lond.)*, vol. 26, no. 305, Nov. 1931, pp. 28–33. Causes of slipperiness; principles of degree of slipperiness of any particular type of road surfacing are common to all ordinary classes of surfacing materials and methods of construction; to minimize dangers of skidding, balance has to be struck between relative proportions of hard and soft materials taking wear of traffic.

VIADUCTS, NEW YORK CITY. Elevated Express Highway, New York City, F. W. Skinner. *Engineering*, vol. 132, no. 3441, Dec. 25, 1931, pp. 799–800, 30 figs. partly on supp. plates XXXVI-XXXVIII. Highway running 14 miles along the shore of the Hudson River; columns are supported on pile foundations; streets are on land reclaimed from Hudson River, filled in over old bulkheads, cribs, and docks; foundations and columns designed for 2-deck structure of which only lower deck is now being built.

SANITARY ENGINEERING

SANITATION. Transmission of Disease by Water, A. W. Burtt. *Surveyor*, vol. 80, no. 2081, Dec. 11, 1931, p. 579. Detection of pollution; water treatment methods; tropical water supplies. Before Inst. Water Engrs.

SEISMOGRAPHY

EARTHQUAKES, JAPAN. Physiographical Change in Shore Lines Due to Great Kwanto Earthquake, 1923, and Older Terraces and Dunes in Coastal Region, K. Inouye. *Ryojun College Eng.-Memoirs*, vol. 4, no. 2-A, Apr. 1931, pp. 63–98, numerous figs, partly on supp. plates. Investigation of region south of Tokyo, Japan.

PRICELESS

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SEWERAGE AND SEWAGE DISPOSAL

CLEVELAND, OHIO. Cleveland's Projected New Activated-Sludge Plant. *Eng. News-Rec.*, vol. 107, no. 27, Dec. 31, 1931, pp. 1034–1036, 3 figs. Construction of sewage works for Easterly district which will provide grease removal, pre-settling, aeration, and sedimentation, with a capacity of 123 m.g.d.; sludge will be digested at Southerly plant; estimated cost $12,000,000.

CONCRETE. Storm-Relief Sewer Details, Dayton, Ohio, G. R. Barte and R. E. VanHorn. *Eng. News-Rec.*, vol. 107, no. 26, Dec. 24, 1931, pp. 1007–1009, 6 figs. Flat-top sections necessitated in places by shallow cover and underground obstructions; pressure manholes and junction chambers; interceptor starts with a diam. of 48 in. increasing to 84 in.; it is of monolithic-concrete construction, with invert liner plates of vitrified clay special sewer sections; sewer siphons.

CONSTRUCTION. Rock Section of Tunnel and Open-Cut Sewer. *Contractors and Engrs. Monthly*, vol. 23, no. 5, Nov. 1931, pp. 65–66 and 80, 1 fig. Construction of horseshoe section and 72- and 81-in. concrete pipe on contracts A, B, and C of Supplementary Joint Trunk Sewer in Elizabeth, N.J.

FERTILIZING EFFECT. Sewage Sludge as Fertilizer, H. J. Harper. *Sewage Works Journal*, vol. 3, no. 4, Oct. 1931, pp. 683–687. General discussion of fertilizing effects of sewage sludge, based on experience and experiments at various plants in the United States. Bibliography.

LIME-CHLORINE TREATMENT. Lime-Chlorine Treatment at Dayton, Ohio, M. W. Tatlock. *Water Works and Sewerage*, vol. 78, no. 12, Dec. 1931, pp. 347–350, 5 figs. Experience of primary treatment plant of the sewerage system of Dayton, Ohio; value of prechlorination for raising plant efficiency in addition to its efficiency in odor control; effects of chlorination; cost data.

NEW YORK CITY. Population Overestimate Reduces Volume of New York Sewage Needing Treatment. *Eng. News-Rec.*, vol. 108, no. 3, Jan. 21, 1932, p. 92. Engineering committee of Merchants Ass'n believes population will be not more than 10,250,000 in 1960 instead of 14,675,000; sedimentation for Hudson sewage.

OPERATION. Notes on Operation of Sewage Treatment Works, W. Donaldson. *Water Works and Sewerage*, vol. 78, no. 12, Dec. 1931, pp. 355–356. Problems in activated sludge process; sludge bulking; lime application corrects bulking; value of "sludge index" determination; drying and disposal of activated sludge; screenings disposal; sludge handling at New Haven, Conn.

RECLAMATION. Purified Sewage as Drinking-Water, Imhoff. *Surveyor*, vol. 80, no. 2081, Dec. 11, 1931, pp. 583–584. Abstract of paper and discussion indexed in Engineering Index 1931, from *Gesundheits-Ingenieur*, Nov. 21, 1931.

SINGAPORE. Sewerage System at Singapore, W. Buchler. *Mun. Sanitation*, vol. 3, no. 1, Jan. 1932, pp. 15–17. Description of sewerage system, 19 years old, serving population of 300,000; bio-flocculation system; sewage pumping stations; filter beds and humus tanks; removal of grit.

SLUDGE. Sludge Ripeness Studies, E. I. Pearson and A. M. Buswell. *Indus. and Eng. Chem.—Analytical Edition*, vol. 3, no. 4, Oct. 15, 1931, pp. 359–360, 3 figs. Study of factors influencing the drying qualities of digested sludge; results of these determinations as made on a series of sludge samples; results of tests on drainability; volatile acids; 24-hour biochemical oxygen demand, ash content, and 24-hour gas-production test. Before Am. Chem. Soc.

WATER SOFTENING PLANTS. Disposal of Water Softening Plant Sludge at Sewage Treatment Plant, Grand Rapids, Mich., E. F. Eldridge. *Mich. Eng. Experiment Station—Bul.*, no. 40, Nov. 1931, 21 pp., 8 figs. Report on experimental studies in which lime sludge was added directly to sewage sludge in varying proportions and progress of digestion was followed by observing the volume of gas produced daily in each of the several mixtures.

STREET CLEANING AND REFUSE DISPOSAL

INCINERATORS, WINSTON-SALEM, N. C. Winston-Salem Combined Incineration of Refuse and Garbage. *Eng. News-Rec.*, vol. 107, no. 27, Dec. 31, 1931, pp. 1046–1048, 3 figs. Report on one year's experience with incinerators serving industrial city of 75,000 population; auxiliary fuel was used only during three summer months of wettest garbage; operating costs (excluding fixed charges) are $2.76 per ton, three-fourths of which is the cost of collection; details of incinerator.

RAILROADS, SNOW REMOVAL. Now You Can Beat a Blizzard. *Ry. Eng. and Maintenance*, vol. 27, no. 11, Nov. 1931, pp. 964–967, 5 figs. Equipment and methods employed by Chicago and North Western in keeping terminal tracks clear; weed burners melt snow.

STRUCTURAL ENGINEERING

COLUMNS, DESIGN. Effect of Existing Regulations on Pillar Design in Steel-Framed Buildings, F. E. Drury. *Structural Engr.*, vol. 10, no. 1, Jan. 1932, pp. 38–50. Basic pillar formula; practical pillar; line of flexure; continuity of pillars; comparison of pillar stress values; eccentric loading; examples; summation of stresses with buckling allowance on flange; preservation of steel in building.

FLOORS, TESTING. Load Tests on Natcofler Construction. *Contract Rec.*, vol. 45, no. 51, Dec. 23, 1931, pp. 1505–1508, 4 figs. Commercial tests of the behavior of two spans of combination concrete and structural clay tile floor slab; load-deflection curves.

RINGS, STRESSES. Elastic Ring, C. E. Larard. *London, Edinburgh, and Dublin Philosophical Mag. and Journal Science*, vol. 13, no. 81, Dec. 1931, pp. 1183–1188. Comparison of strains determined experimentally with strains calculated from elastic-ring theory.

ROOFS, WELDED STEEL. Welded Hip and Valley Roof, F. W. Jacoby. *Welding Engr.*, vol. 16, no. 12, Dec. 1931, pp. 39–42, 11 figs. Field welding increases rigidity and strength, reduces number of component parts, and simplifies connections.

SURVEYING

GEOPHYSICS, SURVEYING INSTRUMENTS. Brunton Compass Attachment for Measurement of Horizontal Magnetic Intensity, J. H. Wilson. *Am. Ass'n Petroleum Geol.—Bul.* vol. 15, no. 11, Nov. 1931, pp. 1391–1397. Construction details of attachment; operation of instrument; theory and derivation of equations; results of several surveys with instrument.

MINES. Accuracy in Measurements of Colliery Survey Lines, W. T. Lane. *Colliery Guardian*, vol. 143, no. 3700, Nov. 27, 1931, pp. 1793–1794. Author concludes that permissible errors should be one in 2,000, but indicates a willingness to agree to increasing this to one in 1,000 during the early stages of any new legislation.

TUNNELS

LINING. Gunite Lining for Montreal Tunnel Sewer, K. O. Guthrie. *Can. Engr.*, vol. 61, no. 26, Dec. 29, 1931, pp. 5–6, 4 figs. Central proportioning, 2-in. hose, steel forms, material pipes driven through ground, and other new methods adopted in construction and lining of sewer tunnel of horseshoe section, 12 by 12 ft.; inside dimension, about one mile long, of which 1,500 ft. are in quicksand.

WATER PIPE LINES

CORROSION. Methods Used to Determine Soil Corrosivity, K. H. Logan. *Pipe Line News*, vol. 4, no. 1, Dec. 1931, pp. 20–24 and 61. Description of various methods; apparatus and procedure.

DESIGN. Formula for Economic Hydraulic Gradient for Conduits, R. A. Hill. *Eng. News-Rec.*, vol. 108, no. 3, Jan. 21, 1932, p. 85. Derivation of formula combining factors of present worth, of loss in head, capital cost, and relation of cost to size.

IDENTIFICATION. Standard Identification of Piping Systems, J. Gaillard. *Maintenance Engr.*, vol. 89, no. 12, Dec. 1931, pp. 615–616. Color identification and letter symbols of five major classes of pipe line contents; classification of materials; classification problems; choice of colors.

SUBAQUEOUS. Laying of Eight-Inch Submarine Pipe Line, E. A. Jeater. *Inst. Engrs. Australia—Journal*, vol. 3, no. 12, Dec. 1931, pp. 438–440. Construction of water pipe line, in Australia, leading from mainland at Ingall Street, Mayfield, to Walsh Island, and to Stockton; organization of field crew; cost data.

WELDING. Arc Welded Pipe Line for Hydraulic Mining, R. F. Allen. *Min. Mag.*, vol. 45, no. 6, Dec. 1931, pp. 329–337, 11 figs. Description of all welded pipe line for supply of water under pressure to monitors used in alluvial mining operations of Viborita Gold Mines in Columbia, South America.

WATER PUMPING PLANTS

DIESEL. Brantford Uses Diesel Engines in New Water Works Station. *Power House, (Eng.)*, vol. 25, no. 11, Nov. 1931, pp. 31–33. Three Diesel engines maintained as stand-by unit and also used for taking peak load from hydro when required in Brantford, Ont.; details of coagulating basin; engine particulars; lubrication system.

EQUIPMENT. Selection and Operation of Centrifugal Pumps, R. B. Hall and S. H. Smith. *Am. Water Works Ass'n—Journal*, vol. 24, no. 1, Jan. 1932, pp. 57–61. Necessity of high initial efficiency; maintaining efficiency; necessity of measuring pump output; advice to plant manager; study of demand curves; elements in purchase.

WATER RESOURCES

DURBAN, SOUTH AFRICA. Report on Water Supply of Durban, W. M. Campbell. *Engineer*, vol. 152, no. 3963, Dec. 25, 1931, pp. 674–676. Review of report by Durban Borough water engineer, on investigations which he carried out with a view to ascertaining the best direction in which to seek a new source of water supply for that town.

RAILROADS, WATER SUPPLY. Keeping "Jack Frost" Out, E. M. Grime. *Ry. Eng. and Maintenance*, vol. 27, no. 11, Nov. 1931, pp. 961–963, 1 fig. Problems and improved equipment and methods for prevention of water freezing; effects of economy measures.

UNDERGROUND. Problems of Groundwater Supply in Florida, D. G. Thompson. *Am. Water Works Ass'n—Journal*, vol. 23, no. 12, Dec. 1931, pp. 2085–2105. Cooperative studies by Federal and state governments; nature of groundwater problems; fluctuations of hydrostatic head.

WATER TREATMENT

CARBON. Use of Charcoal and Activated Carbon in Water Treatment—III, J. R. Baylis. *Water Works and Sewerage*, vol. 78, no. 12, Dec. 1931, pp. 357–362. Chemical characteristics of activated carbon; how adsorption takes place; order of adsorption of various compounds; iso-electric point of charcoal; orientation of molecules adsorbed by carbon; adsorption of acids by charcoal; action of chlorine on carbon; testing adsorptive capacity of carbon. Bibliography.

DECOLORIZATION. Color Removal in Pacific Coast Water Supplies, P. F. Bovard and K. Shibley. *Am. Water Works Ass'n—Journal*, vol. 23, no. 12, Dec. 1931, pp. 2129–2137. Origin of color; studies on coastal water resources; nature of color; decolorization methods; experience at Marshfield, Ore.

FILTRATION PLANTS, HALIFAX. Filtration of Raw Water. *Chem. Age*, vol. 25, no. 644, Oct. 31, 1931, pp. 375–376, 1 fig. Modern practice exemplified by recent installations; water filtration plant completed by Paterson Engineering Company, London, for County Borough of Halifax is the largest of its type in the world and is dealing with 12,000,000 gal. of water per day.

ILLINOIS. Water Softening Plant, W. R. Gelston. *Water Works Eng.*, vol. 85, no. 2, Jan. 27, 1932, pp. 80–81. Quincy, Ill., removes variable hardness of river water by new improvements, including two agitation basins, 17 × 28 ft. in area by 18 ft. deep, equipped with motor driven paddles; Dorr clarifier, 85 ft. in diameter and 16 ft. deep; recarbonation basin, 26 × 39 × 18 ft. deep, and two-story chemical house, 23 × 39 ft.

LIME. Addition of Hyrochloric Acid to Water for Prevention of Scale in Water-Jackets and Condensers, H. Rusden and J. Henderson. *Chem. Met. and Min. Soc. S. Africa—Journal*, vol. 32, no. 5, Nov. 1931, pp. 78–81 and (discussion), pp. 81–83. Practice developed at by-products branch of Witwatersrand Cooperative Smelting Works, to neutralize alkalinity and destroy the bulk of bicarbonate of lime; applicability of method to use in automobile radiators and household hot water systems.

SOFTENING. The Round Table. *Water Works Eng.*, vol. 84, no. 26, Dec. 30, 1931, pp. 1785–1786 and 1803–1804. Practical discussion of performance of water softening plants; average hardness of raw and of softened water; average cost of softening; corrosion problems; effects on distribution system; complaints about changed character of water.

WATER WORKS ENGINEERING

CHINA. Shanghai Water Works Extensions, H. Stringer. *Far East Rev.*, vol. 27, no. 8, Aug. 1931, pp. 469–477, 18 figs. Increase in water consumption in Shanghai from year 1905; new construction; intakes; continuous settlement tanks; filtration; rapid filters; pumping machinery.

DISTRIBUTION SYSTEMS. Kind and Size of Pipe for Water Service. *Water Works and Sewerage*, vol. 78, no. 12, Dec. 1931, pp. 367–368. Symposium of short notes on practice of San Francisco, Calif.; Marshalltown, La., Reading, Pa., Akron, Ohio, and other cities.

FOREIGN. Glimpses of Foreign Water Works, H. E. Babbitt. *Am. Water Works Ass'n—Journal*, vol. 24, no. 1, Jan. 1932, pp. 1–21. Japanese water works; ancient and modern works in Tokyo; new plants at Kobe and Yokohama; international diplomacy and water works; Singapore's supply; Manila's water works; Australian problems; hollow core walls for earth dams; algal troubles on immense scale; Dutch research laboratory at Manggari near Weltevreden (Batavia); water purification in British India; European water works.

GREAT BRITAIN. London Water Supply, J. T. Calvert. *Am. Water Works Ass'n—Journal*, vol. 24, no. 1, Jan. 1932, pp. 110–117. History of water supply and of Metropolitan Water Board.

PROGRESS. Review of Water Works Progress, O. M. Saville. *Water Works Eng.*, vol. 85, no. 2, Jan. 27, 1932, pp. 85–88. Introduction of meters; first installation of cast-iron pipe; wrought iron, steel, and concrete pipe; advance in pumping machinery and dam construction; run-off and watershed computations; rapid and slow sand filtration; improving quality of water; iron removal plants; increase in meterage; advances in other water-works appliances; reduction in typhoid fever death rate; changes in prices.

TROY, N.Y. Troy Water Works, J. M. Caird. *Am. Water Works Ass'n—Journal*, vol. 24, no. 1, Jan. 1932, pp. 49–56. History of water works since 1829; quality of water; state typhoid fever deaths per 100,000 population.